ACCOUNTANTS' COST HANDBOOK

Edited By

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BOARD OF CONTRIBUTING EDITORS

PUBLISHERS' PREFACE

The purpose of this ACCOUNTANTS' COST HANDBOOK is to synthesize from the vast literature of the whole field of accounting for manufacturing costs the important facts, the fundamental principles, and the tested procedures upon which effective analysis and control of costs can be based. This comprehensive information is presented in clear, concise terms, appropriately supplemented with examples and illustrations of proven applications and thoroughly organized for quick and easy reference. Whatever the cost accounting problem may be and whatever the levels of management involved, this HANDBOOK will be found to offer the utmost value in providing expert guidance and support and pointing toward immediate and practical solutions.

The organization and procedures of cost accounting are explained in concrete detail and its relationships with general accounting, engineering, production, and other functions of the enterprise analyzed. This HANDBOOK has been so correlated with the *Accountants' Handbook* (edited by Rufus Wixon), and with the *Production Handbook* (edited by Gordon B. Carson), that together they provide an integrated treatment of the fundamental principles, systems, and methods for the control and management of any manufacturing enterprise.

Demonstrating the sturdy growth in cost theory and practice over a span of more than a quarter of a century, this Second Edition of the ACCOUNTANTS' COST HANDBOOK stems from the *Cost and Production Handbook* (1934), the creation of the late Dr. L. P. Alford, and is based on the organization and concepts which made the First Edition of this HANDBOOK (1944), so ably edited by Theodore Lang, the internationally recognized standard in the field of accounting for costs.

The Publishers have been most fortunate in having secured Robert I. Dickey, Professor of Accountancy in the College of Commerce and Business Administration of the University of Illinois, as Editor for the Second Edition of this HANDBOOK. Building upon the enduring principles established by his predecessors, he has inspired and guided the work of the distinguished group of contributing editors to produce a handbook without peer in its clear, compact, and complete treatment of all phases of costs.

As a complement to such editorial and professional excellence, this edition of the HANDBOOK has been so logically organized, fully cross-referenced, and completely indexed that all the information pertaining to the solution of cost problems can be found without time-consuming research or study and in time to prevent expensive policy or procedural errors. With many refinements in the book's arrangement and format and the use of a larger, more readable page, providing for clearer reproduction of illustrations and forms, the Publishers have added their experience gained from nearly half a century of handbook publishing. This Second Edition of the HANDBOOK is issued, therefore, with the greatest confidence in its value and its reliability.

THE RONALD PRESS COMPANY
Publishers

EDITOR'S PREFACE

Addressed to everyone concerned with manufacturing costs, this HANDBOOK presents practical information on the whole range of accounting for costs in a highly integrated and accessible form. It explains the fundamental cost concepts and principles, presents all major cost systems and the methods and techniques deriving from them, and describes and analyzes proven cost practices, standards, forms, records, and reports.

Each section of this HANDBOOK constitutes a compact synthesis of tested knowledge, selected by a thorough review of the literature and company and individual experience, involving such sources as official pronouncements, research bulletins, professional periodicals and standard books, special reports, pamphlets, and manuals, and surveys of company practices. Manifesting in every detail the authority of the best accounting judgment, this material is interwoven to provide expert and immediate counsel on any cost policy, procedure, or problem for those functioning at every level in management and in accounting. The effects on cost accounting, and on management decisions in turn, of such basic influences as taxation and the law, such economic factors as price level changes and levels of production, and such practical considerations as methods of communication and human relations are reflected throughout the HANDBOOK.

Full credit must be given to the Board of Contributing Editors, so much of whose extensive experience and invaluable judgment has gone into the preparation of this HANDBOOK. While the thinking of each man is reflected in various parts of this integrated work, the editors have made their most significant contributions to the following sections:

Hector R. Anton	Joint Costs
Charles W. Bastable	Job Order Cost Systems
Norton M. Bedford	Nature and Function of Cost Accounting
Lawrence J. Benninger	Cost Classifications
Kenneth B. Berg	Materials
R. Lee Brummet	Manufacturing Overhead and Normal Activity
A. B. Carson	Distribution of Manufacturing Overhead
Donald H. Cramer	Process Cost Systems
Wilber C. Haseman	Manufacturing Overhead and Product Cost
Leon E. Hay	Setting Standard Costs
George A. Horch	Cost Accounting Department
Robert K. Jaedicke	Accumulation of Manufacturing Overhead
G. Kenneth Nelson	Operation of Standard Costs
Oswald Nielsen	Estimated Costs
A. W. Patrick	Cost Control, Budgets, and Reports
Kenneth W. Perry	Estimated Costs
Michael Schiff	Special Cost Analyses
William J. Schlatter	Analysis and Control of Standard Cost Variances
Robert E. Schlosser	Basic Cost Records
Robert E. Seiler	Labor Costs

Gordon Shillinglaw .... Cost-Volume-Profit Relationships
William A. Terrill .... Cost Control, Budgets, and Reports

Finally, the editor must express his sincere gratitude for the enthusiastic cooperation with which the National Association of Accountants and numerous other professional societies, companies, and individuals have provided valuable counsel and significant materials for the HANDBOOK. Special thanks are rendered to Dr. Walter B. McFarland, Manager of Research of the National Association of Accountants, George R. Catlett, partner in Arthur Andersen & Co., and Thomas A. Yancey, Assistant Professor of Economics at the University of Illinois, for their advice and aid on a number of matters. The editor is particularly grateful to Dr. Raymond P. Marple, Assistant Secretary of the NAA, who gave helpful advice at various stages in the preparation of this HANDBOOK. The many publications referred to in the preparation of the book are acknowledged specifically elsewhere.

ROBERT I. DICKEY

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NATURE AND FUNCTION OF COST ACCOUNTING

Nature of Cost Accounting

DEFINITION. The field of cost accounting may be defined broadly as the art of determining cost. Normally it is conceived as a process of determining costs for managerial purposes. Beyond this there is a definite lack of agreement among accountants as to the precise nature of cost accounting. Definitions available, however, tend to cluster around two rather distinct **views of cost accounting,** as follows:

1. The narrow view of cost accounting restricts the field to the determination of the historical cost of manufacturing in terms of departments, cost centers, and products. These costs may or may not be compared with standard costs for control purposes. According to this view, budgeting, distribution cost analysis, and similar functions are distinct from cost accounting.
2. The broad view of accounting places on the field the responsibility for advising management on both historical and future costs in such a manner as to contribute directly to managerial planning and control of organization and operations. According to this view, distribution cost analysis does not differ from manufacturing cost determination. Both are required to advise management on the nature of operations. Budgeting, under the broad view, is only one aspect of the function of providing management with information on future costs.

The most appropriate definition of cost accounting seems to lie between these two extremes. Possibly the most objective over-all view of cost accounting practice is that provided by a group of European experts who, under the auspices of the Organization for European Economic Co-operation, visited many companies in the United States to observe how cost accounting was used in practice. In its report (Cost Accounting and Productivity) the team observed:

The primary purpose of cost accounting in America appears to be to assist management to control costs, and to create or intensify an awareness of the importance of cost to the well-being of the company—or in other words to stimulate "cost-consciousness." The ascertainment of product unit cost, although by no means disregarded, is of secondary importance.

Gillespie (Cost Accounting and Control) provides the following **functional classification** of the activities included under the general term of cost accounting:

1. **Cost bookkeeping,** involving the recording of costs according to pre-arranged classifications.
2. **Cost control,** the determination of whether the current costs represent what is regarded as a satisfactory performance.
3. **Cost analysis,** the determination of why costs are out of line and who is responsible.

4. **Cost comparison,** the comparison of the cost of alternative products, activities, methods, or areas in the field of production or distribution.
5. **Cost planning,** or strictly speaking, cost system or procedure planning.

Kohler (A Dictionary for Accountants) refers to cost accounting as:

. . . that branch of accounting dealing with the classification, recording, allocation, summarization, and reporting of current and prospective costs. Included in the field of cost accounting are the design and operation of cost systems and procedures; the determination of costs by departments, functions, responsibilities, activities, products, territories, periods, and other units, of forecasted future costs and standard or desired costs, as well as historical costs; the comparison of costs of different periods, of actual with estimated or standard costs, and of alternative costs; the presentation and interpretation of cost data as an aid to management in controlling current and future operations.

Nickerson (Cost Accounting) tends to cover both the narrow and broad view of cost accounting in stating:

In the early stages of its development, cost accounting dealt in large part with factory costs for use in inventory valuation, profit determination, and pricing. These are still important aspects of cost accounting, but the field has been expanded in areas such as cost control, budgeting, and cost determination for a variety of managerial uses and has been broadened to include administrative expenses and distribution costs and the cost and control problems of nonmanufacturing businesses.

A distinction between the narrow and broad view of cost accounting is sometimes attempted by distinguishing **cost finding** and cost accounting. Cost finding is defined as the determination of the cost of goods or services by informal procedures; that is, procedures that do not carry on the regular processes of cost accounting on a continuous basis. Actually, however, other than the fact that implementation of the broad view requires both the informal and the regular procedures, cost finding is not exclusively related to the broad view of cost accounting.

PROCEDURES. There is a tendency to think of cost accounting in terms of the procedures used in determining cost. In this sense cost accounting, according to the narrow view of the field, represents the set of procedures involved in a **job order** or **process cost** accounting system. Upon either of these two sets of procedures, **standard costs** may be superimposed; this adds another set of procedures to provide measures of variances of actual costs from standard costs. Beyond the three sets of procedures, individual companies have developed additional cost accounting procedures for various phases of the art of determining cost. Because of the lack of uniformity among cost accounting procedures in different companies, definitions of cost accounting tend to be expressed in general terms or concepts to provide an explanation of the variety of activities in the field.

The great variety of procedures in use in the area encompassed by the broad view of cost accounting tends to preclude the drawing up of any list of procedures generally followed. There is, however, a tendency under this view to describe the procedures for determining **costs useful to management** as:

1. Those useful in planning future activities for the company.
2. Those useful in controlling current activities of the company.
3. Those useful in measuring company periodic income.

This point of view seems to be the basic principle underlying the approach by the Committee on Cost Accounting Concepts and Standards of the American

Accounting Association (Accounting Review, vol. 31) in that the concepts discussed center around these three areas. In line with this general description of the procedures of cost accounting, Neuner (Cost Accounting) includes the following specific procedures for determining costs useful in **planning profitable operations:**

1. Profit planning through direct costing procedures.
2. Profit planning through cost-volume-profit studies and break-even charts.
3. Profit planning through differential and comparative cost analyses.

Specific **control procedures** beyond those included in the narrow view of the field, include, among others:

1. Procedures for measuring the rate of return on capital invested.
2. Procedures for assigning and collecting costs by personal responsibilities, especially in the form of budget comparison.
3. Procedures for effective reporting of information to management, including the development of a specific cost reporting system.

AREAS OF COST ACCOUNTING. Areas of activity which represent segments of the field of cost accounting include budgeting, cost control, cost analysis, inventory valuation, and special investigations.

Budgeting. The preparation and use of budgets involves the development of a set of estimates of future costs and revenues in such form as to coordinate company activities in accordance with selected objectives or goals and to serve as a standard for cost control. Heiser (Budgeting—Principles and Practice) defines the **budget** as "an over-all 'blueprint' of a comprehensive plan of operations and actions, expressed in financial terms." He conceives the budgeting process as "the preparation of a budget and its fullest use, not only as a device for planning and coordinating, but also for control."

Cost Control. According to Kohler (A Dictionary for Accountants), cost control represents:

> . . . the employment of management devices in the performance of any necessary operation so that pre-established objectives of quality, quantity, and time may be attained at the lowest possible outlay for goods and services. Such devices include a bill of materials; instructions; standards of performance; competent supervision; cost limits on items and operations; and studies, interim reports, and decisions based on these reports.

This definition of cost control implies that cost accounting is only one of several techniques used in controlling costs. There is a tendency to confine the role of cost accounting in this area to the comparison of actual costs with a standard of some form in order to report areas of unsatisfactory performance to management. Some authorities suggest that **responsibility accounting** through the process of materials requisitions and similar documentary authorization for using resources represents another use of cost accounting in the area of cost control. For a detailed discussion of cost control and responsibility accounting see the section on Cost Control, Budgets, and Reports.

Cost Analysis. The process of **re-arranging** and **reclassifying** cost and revenue data in such manner and detail as to reveal significant relationships to management is known as cost analysis. Statistical data, in addition to the basic cost accounting information, are used in developing significant reports for manage-

ment. Authorities have different views of the areas covered by cost analysis. Devine (Cost Accounting and Analysis) suggests a general view as follows:

Further duties of cost accountants arise in connection with decisions for re-arranging machines and operations, for exchanging equipment, etc. Some accountants have preferred to include these special calculations in a class designated as cost analysis instead of cost accounting.

Inventory Valuation. The primary center encompassed by the general area of cost accounting is often assumed to be inventory valuation. For purposes of income taxation, credit, and similar business features, most firms need a basis for valuing inventory. Without a systematic **manufacturing cost accounting system**, valuation would be difficult.

Special Investigations. In addition to the rather definite functions outlined by Devine and others, cost accountants are called upon to perform a host of special investigations which extend beyond any analysis of cost and statistical data and which may include analyses that require considerable judgment and experience in dealing with intangible factors not capable of measurement.

Relationship to Other Fields

COST ACCOUNTING AND FINANCIAL ACCOUNTING. The boundaries of any field tend to merge into those of other fields. Understanding of cost accounting, therefore, requires recognition of its relationship to other disciplines and organized bodies of knowledge. Different distinctions may be drawn between cost and financial, or general, accounting, depending upon the individual's understanding of the term "cost accounting." Russell (NAA Bulletin, vol. 29) states that "Financial accounting is concerned chiefly with the requirements of creditors, owners, the government, prospective investors, and persons outside of the management," whereas the chief characteristic of cost accounting is that it is directed primarily to **management requirements.**

Matz–Curry–Frank (Cost Accounting) distinguish the two fields in the following terms:

It is usual to consider cost accounting to be that phase of general accounting which informs management of the unit cost of the goods manufactured and sold. General accounting classifies, records, presents, and interprets in terms of money, transactions, and events that are of a financial character, thereby providing management with the facts and figures necessary for the preparation of the periodic financial statements—the balance sheet and the income statement. Cost accounting, on the other hand, classifies, records, presents, and interprets in a significant manner the cost of materials, labor, and expenses necessary to manufacture and sell each product. The year-end statements of general accounting, presenting the total cost figures, can thus be supported by the details of these costs that have been collected through cost accounting methods and procedures.

Neuner (Cost Accounting) supports the view that collected cost accounting data are to be controlled by and subsidiary to the data in the general financial accounting system in order to provide an integration of cost and financial accounting systems, but he states:

It should be added, however, that in most nonmanufacturing costs such as distribution costs, office costs, municipal costs, and bank costs, the use of statistical compilation and analysis (which are not integrated with the financial accounting system) has been proven more economical and equally effective.

Devine (Cost Accounting and Analysis) treats cost accounting from a broad view and considers general or financial accounting to be cost accounting "in the sense that the determination of income requires the assembling of costs and their assignment to operating periods." The view underlying this distinction implies that cost accounting is an extension of financial accounting.

In general there are certain phases of cost accounting which are detailed procedures in support of, and tied into, accounts used in general accounting. There are other aspects of cost accounting which extend the activities of the field well beyond any work performed in the field of financial accounting.

COST ACCOUNTING AND MANAGEMENT ACCOUNTING. In recent years the term "management accounting" has become rather widely used. It is generally employed to cover a broad area. Anthony (Management Accounting) describes it simply as "concerned with accounting information that is useful to management." Pelej (Journal of Accountancy, vol. 105) defines it as "that phase of the accounting function which is directly concerned with aiding management's planning and administrative tasks," and says that essentially it is a change in perspective from that of historical accounting. Keller (Management Accounting for Profit Control) states:

> Management accounting for profit control includes income accounting, cost accounting, and budgetary planning and control. Of these processes cost accounting is the keystone. . . . Actual costs must be determined and compared with those planned to guide management toward their profit objective. . . . Costs must be determined not only in total but also by areas of management responsibility and by products.

Crossman (Accounting Review, vol. 33) says:

> Management accounting functions largely through operating reports based upon standard costs and budgets compared with actual expenditures, through internal auditing, and through special duties and reports pertaining to the probable effect of proposed plans and programs.

The American Accounting Association's 1958 Committee on Management Accounting (Accounting Review, vol. 34), after studying the evolution and present status of management accounting, arrived at the following definition:

> Management accounting is the application of appropriate techniques and concepts in processing the historical and projected economic data of an entity to assist management in establishing a plan for reasonable economic objectives and in the making of rational decisions with a view toward achieving these objectives. It includes the methods and concepts necessary for effective planning, for choosing among alternative business actions, and for control through the evaluation and interpretation of performance. Its study involves consideration of ways in which accounting information may be accumulated, synthesized, analyzed, and presented in relation to specific problems, decisions, and day-to-day tasks of business management.

The Committee observes that, "In the broad sense all accounting is management accounting," but that in a restricted sense, "management accounting is distinguished by emphasis upon purpose, the point of view predominating, and upon potential management use."

COST ACCOUNTING AND INDUSTRIAL ENGINEERING. Cost accounting is normally viewed as a process of determining a cost measured in terms of money. It is true, of course, that considerable statistical data are a part of the more effective cost systems, but such data are considered supplemental to the basic cost accounting function of determining a money cost. Industrial en-

gineering is concerned with cost also but more from the point of view of technical efficiency than with cost measured in terms of money. In the area of **standard cost**, for example, industrial engineers may determine the physical amount of materials and labor appropriate for the standard, and the cost accountant may assign an appropriate dollar amount to the physical measurements. **Budgeting** is recognized as an accounting function, but many cost studies in such areas as **machine replacement** and evaluation of alternative plans for future action often are considered by industrial engineers to be in the industrial area. (For a discussion of the relationships of the cost accounting department to other departments of the company, see the section on the Cost Accounting Department.)

COST ACCOUNTING AND OPERATIONS RESEARCH. Cost accounting includes not only the collection of cost data useful to management but also the arrangement and presentation of such data in such form as to reveal **significant relationships** to management. This same objective may be applied to the experimental and mathematical techniques of operations research. Many of the data now presented as work of operations research have been presented in a less analytic manner by cost accountants for some time. Operations research may be viewed as supplementing the cost accounting function of providing management with information useful in planning and control decisions by means of scientific and statistical methods of analysis. As Kozmetsky and Kircher (Electronic Computers and Management Control) point out:

As our economy has become more complex, and as corporations have grown in size, in variety of products, and in extent of market, the need for improved systems of planning and control, and data processing, has become increasingly evident. Executives have recognized this need. They have purchased or leased office machines, analyzed procedures, and encouraged attempts to raise clerical efficiency. They have studied reporting systems. They have attempted to relate the gathering and processing of information to the decision needs of the organization. . . . In both office and factory, and for certain types of engineering and other research as well, there also has been a development of certain new scientific methods of analysis. These methods use tools which are primarily mathematical in nature, although not necessarily so. One of the names given to this development is "Operations Research."

(For a more detailed discussion of operations research, see the section on Special Cost Analyses.)

Objectives of Cost Accounting

MAJOR GOALS. Although there may be differences of opinion as to the purposes of cost accounting, there seems to be general agreement on the three objectives stated by Lang–McFarland–Schiff (Cost Accounting):

1. To aid in determination of profit or loss, including inventory valuation.
2. To aid management in planning.
3. To control operating efficiency.

Williams (NAA Bulletin, vol. 39) comments on these general objectives in the following terms:

In profit measurement the cost accountant is concerned primarily with the proper recording of profit or loss for operations or transactions which have already occurred. His work in this connection does not of itself yield any profit for his company. In cost control, the accountant is working in the present rather than the past. He is concerned with operations as they occur, and in this function he is able to render some assistance in the development of profits by means of cost reduction.

The cost department's most important role is that in developing costs for management decisions. In this role the cost accountant is concerned with the future, and it is here that he finds his greatest opportunity to contribute to the profit of his company.

INCOME DETERMINATION. Goetz (Management Planning and Control) states:

Management, and consequently managerial accounting, is concerned with the efficiency of an individual industrial enterprise. Management's search for economic efficiency may be analyzed into three groups of activities; (1) planning enterprise activities, (2) controlling enterprise operations, (3) conducting social contacts.

Planning Future Activities. Income determination plays a role in all three of the suggested activities, but as a report on past activities it is most useful in planning future activities, provided it is reasonable to assume that the environment of the future will be similar to that of the past. For example, **variable costs,** computed in determining income, may be useful in planning future activities if it is assumed that the present environment will exist in the future. Many cost accountants use the **historical data** available from the process of determining income as the basic information for developing cost data more directly applicable to future planning. The process involved is one of correcting or adjusting historical cost data to the environment which is forecast for the future.

Controlling Costs. In the area of cost control, **measured income** is used as a broad over-all gage of efficiency. When reported income is unsatisfactory, managements are motivated to take steps to see that plans are carried out efficiently. In the sense that income reports serve to motivate action, they are considered to contribute to the managerial objective of controlling costs. Possibly the control aspect arises primarily from the process of measuring income. This is so because of the need to account for all utilized goods and services when measuring the expenses charged against revenue. All resources are thus accounted for, either as expenses or as assets still on hand. If the services utilized are collected by **individual responsibility,** then as they are measured for purposes of determining income, data are collected which serve to control operations. It is contended by some authorities that the process of collecting cost by personal responsibility serves to motivate the person involved to control costs.

Fulfilling Obligations. In the fulfillment of social obligations, income determination must be computed for several purposes. As a **report to stockholders** on the amount of earnings which may be available for payment of dividends, the income statement serves a useful purpose for persons other than management. As a means for assessing an income tax, governments are served when income is determined accurately. Because management does have to fulfill such social obligations, income is determined as a means of complying with the implied or explicit contract with persons other than management, those representing society in general.

Data derived from the income determination process serve only as rough approximations of the best information needed for planning and control. There are other cost data which the cost accountant has developed as more specific guides to management in performing the planning and control functions. While there may be other data more appropriate for fulfilling social obligations, public acceptance of measured income as a means of compliance with social contracts suggests that the process of reporting income determination serves this function well.

CONTROL. The objective of cost accounting in the area of determining income is to provide information useful for several purposes. One of these purposes is cost control. It should not be assumed, however, that cost accounting is concerned with cost control only as an incidental result of the objective of determining income. To the contrary, cost control is a distinct objective of cost accounting and may be attained by processes and methods unrelated to the process of measuring income.

Control may be defined as the process of directing a set of variables toward a preconceived objective. In this sense the cost control objective refers to the process of preventing costs from varying from the amount planned or computed as a proper cost for operations. Thus it is one phase of the operational function of carrying out the plans of management. The role and activity of cost accounting in this area has been classified as: (1) after-the-fact cost control procedures, and (2) before-the-fact cost control procedures.

Corrective Control. In a sense, after-the-fact or corrective control is a misnomer. It is impossible to control any cost after the amount incurred has exceeded the amount allowed as a proper cost. The concept refers to the process of constantly checking **current cost performance** with planned, budgeted, or **standard cost allowances** and of reporting variances immediately to management so that action may be taken to prevent recurrence of undesirable variances from the standard. The effect of the application of after-the-fact control procedures is to encourage managerial control of specific areas of future costs. Corrective control serves only as a motivating mechanism in the sense that an unfavorable variance report stimulates management to take action to control costs in the future.

Preventive Control. There seems to be a definite trend among cost accountants to direct cost control more and more to the objective of before-the-fact, or preventive control. The concept is that various procedural, psychological, and physical stimuli should be established to motivate employees to keep costs within those allowed by standards, budgets, and other planned costs. In implementing this concept of control, cost accountants have established procedures whereby requisitions for materials and labor in excess of a standard allowance require special approval and involved procedures of such a nature as to encourage efficient utilization of resources. **Standard costs** and **formal budgets** serve as psychological stimulation, motivating employees to work efficiently to meet the predetermined objective.

In the area of the object controlled, there appears to be a change taking place in the cost accounting objective of cost control. Until recent years the concept underlying cost accounting cost control has been that the items to be controlled were the resources of the company. The objective of this concept of control was to prevent excess usage of materials, labor, and overhead by protecting these resources from being wasted by employees. The more recent concept of cost control by cost accountants is that it is people or employees who should be controlled, and that by control of people and proper motivation of people, resources control will be accomplished much more effectively. The ultimate result of both concepts is the same, but in the older version, attention is centered on means of **resource control,** whereas the newer concept places emphasis on **personnel motivation** to perform well.

PLANNING. The objective of aiding management in planning future activities of the company has been accepted relatively recently by cost accountants as one of their primary responsibilities. Cost accounting has been useful in many

areas of planning (such as pricing, when historical cost data have been used), but the development of systematic planning of future activities of the company represents the area of cost accounting where the greatest expansion of the field has taken place.

Cost accounting objectives in the area of planning include aiding management in reaching decisions on:

1. **Project plans,** such as plant location, resource replacement, volume expansion, and similar special planning activities.
2. **Period plans,** such as budgeting, where an attempt is made to estimate future costs and revenues of a co-ordinated plan of company activity for a coming period of time.

Nature of Cost

COST, EXPENSE, AND LOSS. The AICPA Committee on Terminology (Accounting Terminology Bulletin No. 4) distinguishes "cost," "expense," and "loss" as three terms which are sometimes used interchangeably. The Committee defines cost as "the amount, measured in money, of cash expended or other property transferred, capital stock issued, services performed, or a liability incurred, in consideration of goods or services received or to be received."

Expense in its broadest sense is defined by the Committee as including "all expired costs which are deductible from revenues." In a narrower sense "the term 'expense' refers to such items as operating, selling, or administrative expenses, interest, and taxes." The Committee appears to favor the narrower definition for use on financial statements and recommends that "items entering into the computation of cost of manufacturing, such as materials, labor, and overhead, should be described as costs and not as expenses."

Loss is defined by the Terminology Committee as:

> (1) the excess of all expenses, in the broad sense of that word, over revenues for a period, or (2) the excess of all or the appropriate portion of the cost of assets over related proceeds, if any, when the items are sold, abandoned, or either wholly or partially destroyed by casualty or otherwise written off. When losses such as those described in (2) are deducted from revenues, they are expenses in the broad sense of that term.

The Committee recommends that in financial statements the term loss should refer to net or partially net results when appropriate in place of the term "income" or "profit." In such cases appropriate qualifying adjectives should generally be used. The term should also be used in describing results of specific transactions, generally those that deal with the disposition of assets.

COST VARIES WITH PURPOSE. Years ago, Clark (Studies in the Economics of Overhead Costs) stated:

> We may start with the general proposition that the terminology of costs is in a state of much confusion and that it is impossible to solve this confusion by discovering and adopting the one correct usage, because there is no one correct usage, usage being governed by the varying needs of varying business situations and problems.

More recently the Committee on Research of the National Association of Accountants in NAA Research Series No. 7 (NAA Bulletin, vol. 27) recognized the need for different costs for different purposes:

> Costs are used for a variety of purposes and the same cost data cannot serve all purposes equally well. Many of the apparent differences of opinion among cost

accountants are not fundamental but arise from failure to recognize that cost data prepared for one purpose may not be appropriate for other purposes.

In support of this general statement the Committee classifies five **uses of cost data** and suggests that their collection and analysis be directed toward:

1. Determination of periodic profit, including inventory valuation.
2. Budgetary planning.
3. Cost control.
4. Pricing policy.
5. Current applications of plans and policies.

The Committee goes on to discuss the different types of costs needed for each purpose. Historical costs are needed for the process of measuring periodic profit (1), since it involves the matching of incomes and costs on some consistent basis. Management requires the best possible estimates of expected actual costs for each set of conditions being reviewed, in its budgetary planning (2), where it is concerned primarily with the combination of income, costs, and volume most likely to yield the greatest net profit return. Cost control (3) requires the adoption of standards of comparison and involves the measurement of actual costs against the predetermined standard costs. Management needs projected product costs, based on its determination of normal capacity, in order to serve the purpose of pricing policy (4), which is to determine the product price that will permit a maximum total profit over a period of time. Once long-term pricing policies have been decided, deviations to meet short-term conditions require cost and other data based on these conditions. Current applications of plans and policies (5) may require almost any combination of these and other types of costs, drawn from regular cost reports or assembled to meet the needs of the moment.

Authorities appear to agree in general that different costs are appropriate for different purposes and that it is not possible to say what the cost of something is without knowing the use to which the cost is to be put. The Commitee on Research took a similar position on **standard costs** in NAA Research Series No. 11 (NAA Bulletin, vol. 29), suggesting that different standard costs may be needed for the different uses of cost control, inventory costing, budgetary planning, pricing, and for facilitating bookkeeping.

BASIC CONCEPT OF COST. Underlying all the various measurements involved in determining the most appropriate cost for various purposes is the idea that cost represents a **sacrifice**, a foregoing or a release of something of value. Devine (Cost Accounting and Analysis) states, "The core of meaning which is common to all types of cost may be summed up by the word sacrifice. It is not by chance that accountants speak of cost as effort exerted and that political leaders talk of having cannons instead of butter." The Committee on Cost Concepts and Standards of the American Accounting Association (Accounting Review, vol. 31) supports the view that business cost is a **release of value**:

> For business purposes, cost is a general term for a measured amount of value purposefully released or to be released in the acquisition or creation of economic resources, either tangible or intangible. Normally it is measured in terms of a monetary sacrifice involved. There is, however, nothing to prevent its measurement in other terms nor to prevent the adjustment of monetary sacrifices to common units of purchasing power.

CONCEPTS OF HISTORICAL COST. Cost accountants are concerned with all the different costs for different purposes, but when cost accountants are concerned with the procedure of reporting significant historical cost data, there is

general support for the view that the cost of something refers to its **acquisition cost**. Thus the cost of a machine is the cash or cash equivalent given up on the acquisition date to acquire the machine. When the machine is used to produce a product, the **depreciation** is measured as a portion of the original acquisition cost of the machine. Even this concept is subject to a variety of measurements, due either to measurement difficulties. the result of efforts to approximate more fundamental notions of the appropriate cost, or the desire to classify this concept into distinct categories to provide detailed information on company activities. The most common distinction drawn is between manufacturing and nonmanufacturing costs. **Manufacturing costs** are considered to be the costs of physical creation of a product and represent all costs of the factory producing the product. **Nonmanufacturing costs** include the costs of distributing the product and the general administrative costs not directly associated with either production or distribution.

Other classifications of historical acquisition costs result in further breakdown to provide cost information more directly usable for different purposes. (For a detailed discussion, see the section on Cost Classifications.)

DEFINITION OF TYPES OF COSTS. The idea of different costs for different purposes is applicable to both costs in general and to historical acquisition cost. The word "cost" is used in such a wide variety of ways that it is advisable to use with it an adjective or phrase which will convey the shade of meaning intended. The AAA Committee on Cost Concepts and Standards (Accounting Review, vol. 27) defines the following types of cost:

1. **Historical cost** is cost measured by actual cash payments or their equivalent at the time of outlay.
2. **Future costs** are costs expected to be incurred at a later date.
3. **Replacement cost** is cost in the present market.
4. **Standard costs** are scientifically predetermined costs.
5. **Estimated costs** are predetermined costs.
6. **Product cost** is cost associated with units of output.
7. **Period cost** is that cost associated with the income of a time period.
8. **Direct costs** are those costs obviously traceable to a unit of output or a segment of business operations.
9. **Prime costs** are the labor and materials costs directly traceable to a unit of output.
10. **Indirect costs** are those costs not obviously traceable to a unit of output or to a segment of business operations.
11. **Fixed costs** are those costs which do not change in total as the rate of output of a concern or process varies.
12. **Variable costs** are those costs which do change in total with changes in the rate of output.
13. **Opportunity cost** is the measurable advantage foregone as a result of the rejection of alternative uses of resources, whether of materials, labor, or facilities.
14. **Imputed costs** are costs that do not involve at any time actual cash outlay and which do not, as a consequence, appear in the financial records; nevertheless such costs involve a foregoing on the part of the person or persons whose costs are being calculated.
15. **Controllable costs** are those costs subject to direct control at some level of managerial supervision.
16. **Noncontrollable costs** are those costs not subject to control at some level of managerial authority.
17. **Joint costs** exist when from any one unit source, materials, or process, there are produced units of goods or sources which have different unit values.
18. **Sunk costs** are historical costs which are irrecoverable in a given situation.

19. **Discretionary costs,** often termed "escapable" or "avoidable" costs, are those costs which are not essential to the accomplishment of a managerial objective.
20. **Postponable costs** are those costs which may be shifted to the future with little or no effect on the efficiency of current operations.
21. **Out-of-pocket costs** are those costs which, with respect to a given decision of management, give rise to cash expenditure.
22. **Differential costs** are the increases or decreases in total cost, or the changes in specific elements of cost, that result from any variation in operations.

Development of Cost Accounting

ORIGINS OF COST ACCOUNTING. Garner (National Public Accountant, vol. 1) observes that many people have the erroneous impression that cost accounting developed from general accounting during the last half century. It is also substantially incorrect that cost accounting originated with the rise of the factory system in the Industrial Revolution in England in the latter part of the eighteenth century. Many cost accounting practices and theories are much older, dating back to about the fourteenth century when small industrial enterprises were established with the growth of Italian, English, Flemish, and German commerce. Few authorities suggest, however, that many of the present-day cost accounting procedures came into being prior to 1880.

EARLY DEVELOPMENTS. Garner (Evolution of Cost Accounting to 1925) suggests growth along various lines in discussing developments in cost accounting from 1880 to 1920. In the early stages Garcke and Fells suggested a thorough technique in accounting for materials, using a stores ledger, a materials requisition (termed "stores warrant"), and a stores-received book. Metcalfe provided a satisfactory method of accounting for labor time and cost by having employees use time cards and a time book, filling out the time cards as they moved from job to job. Norton suggested the distinction between manufacturing and nonmanufacturing costs.

Around the turn of the century there was growth in many areas. Lewis distinguished prime costs (wages, materials, and other direct items), shop establishment charges (other shop items), and general establishment charges (operating nonshop costs). Maximum and minimum materials-quantity notation space was added to the stores ledger card about this time, and bills of materials were advocated for control of materials usage. Factory burden was recognized as a distinct element to be allocated to jobs, and labor costs were collected by departments. Perpetual inventory plans were suggested, first-in, first-out (FIFO) was advocated, and the ideas of a normal price and the average cost basis of pricing requisitions were presented.

The question of interest as a cost was debated at some length later in this period (1906–1916). Controlling accounts on the general ledger were used for indirect manufacturing costs, detailed in a subsidiary ledger. Predetermined burden rates were used to apply estimated burden and departmentalization in terms of service department and production department costs were well recognized.

LATER BROAD DEVELOPMENTS. According to Jackson (NAA Bulletin, vol. 34) there were five broad developments in the field of cost accounting during the period (1920–1945) along the following lines:

1. Improvement and refinement in cost accounting procedures, techniques, and principles in areas of developing and using standard costs, distributing factory overhead, handling of materials, recording cost variations in the double-entry system, preparing cost reports, and others

2. The extension of costing methods to practically all businesses and to the major functions within the business, especially the extension of cost accounting methods to the distribution phase of business operations,
3. Establishment within individual companies of the use of costs for cost determination, management guidance, and pricing. There was also the establishment of the important distinction between the use of costs within an industry to fix prices and restrain trade (which was ruled unlawful), and the collection and dissemination on costs by trade associations or others without any attempt to fix prices or restrain competition (which was ruled permissible). (U.S. vs. Maple Flooring Manufacturers' Association, U.S. District Court, W.D. Mich., Final Decree, Jan. 4, 1924, appealed March 28, 1924. U.S. Supreme Court Docket No. 342.)
4. The development and extension of cost accounting into the area of cost control and its use for cost reduction methods.
5. The development of the budget and its extension in the form of a flexible budget for use with standard costs.

Standard Costs. The first Annual Conference of the National Association of Accountants in 1920 revealed considerable interest in standard costs, but the discussion indicated a wide divergence of opinion regarding the use and application of standard costing technique. Subsequent to that meeting, however, standard costs developed rapidly. The **scientific management** movement undoubtedly contributed to the use of standard costs in planning manufacturing operations and in evaluating the efficiency with which work was done. The early standards were physical standards expressed in number of units of materials or hours of labor. These were soon converted into cost standards. As budgeting developed, it became possible to develop standards for controlling the indirect costs and for determination of a standard unit product cost.

The thinking which led to the development of standard costs appears to be an extension of cost estimating methods coupled with the prior development of predetermined factory overhead rates. (For a detailed discussion of standard costs, see the sections on standard costs.)

Cost Control. In NAA Research Series No. 9 (NAA Bulletin, vol. 28), the Research Committee of the National Association of Accountants states in summary that good **cost control practice** in the period before World War II involved:

1. The classification of costs in terms of:
   a. Nature of expenditure.
   b. Responsibility.
   c. Variability.
2. The predetermination of costs in the form of planned or standard costs and budgets.
3. The accumulation of actual costs.
4. The comparison of actual costs with cost or budget standards in order to determine what variances had occurred and the causes of these variances.
5. The prompt reporting of variances to those individuals having authority to incur costs, as well as to the next level of management.
6. Managerial action to eliminate unfavorable variances when actual costs differed from standard costs or budgets.

The growth of cost control to its position just prior to World War II may be traced back to an origin around 1900. At that time cost control practice consisted of the collection of current actual cost for comparison with costs of prior periods. Such **cost comparisons** were used to indicate the trend of costs.

Improvement in this process of cost control resulted when more detailed and significant cost classifications were developed. The development of a **fixed budget** or forecast of future operations provided a basis of comparison of actual with the predetermined goals. As physical or engineering standards were devised, **standard costs** were developed to supplement budgetary control. When comparisons of actual cost with some type of a standard became established, reporting practice changed so that only variances from standards were submitted to management as the cost data required for control. Timeliness of reports became the center of interest as the objective became one of correcting unfavorable variances before they accumulated into large losses. More cost reporting resulted, and these reports were more widely distributed throughout the company. This appears to have been the status of cost control just prior to World War II.

The effect of World War II on cost control was negative. With cost-plus contracts and the pressure of the war effort, interest in consistent effort to reduce cost decreased as emphasis centered on production speed and volume. Shortage of accounting personnel and the need for collecting actual costs for renegotiation and contract termination added to the difficulties of maintaining cost control. (See the section on Cost Control, Budgets, and Reports.)

RECENT DEVELOPMENTS. The most evident development in cost accounting since 1945 has been the interest in providing data useful to **management planning** of the future activities of the company. The second significant development has been the extension of cost control. Some authorities view both developments as advancement in the area of cost control on the grounds that cost control includes control of future operations as well as current activities. Whatever the classification of the new work, cost accounting has assumed responsibility for aiding management in planning future activities. The functions performed in this process have not been crystallized into standardized activities. According to Carlson (NAA Bulletin, vol. 38) "the need to plan is recognized in developing long-range and short-term budgets and forecasts. Other targets of performance, such as cost standards, product profit margins, inventory turnover, and return on capital, also fit the planning requirement."

Electronic Data Processing. Associated with the growth of interest in planning has been the development of electronic data processing. Hollander (NAA Bulletin, vol. 38) states:

> The advent of electronic data processing is the latest development in the long history of efforts to mechanize data flow and office clerical routines. In their day, the introduction of the typewriter, adding machine, cash register, desk calculator, accounting machine, and punched card systems were all revolutionary in their impact on the formerly well-entrenched techniques. However, all these devices were merely mechanized extensions of a manual concept, since they were basically tools for printing, calculating, and totaling.
>
> It is a virtual certainty that future business historians will relate all data handling developments to the pre-electronic or post-electronic era. This division is significant because, unlike all earlier devices, electronic data processors represent an entirely new concept of data-management relations. For the first time, a technique is available for automatically implementing routine top management decisions.

(For a discussion of electronic data processing, see section on Basic Cost Records.)

Control Accounting. The more recent history of cost accounting is in the area encompassed by a broad view of the field (see the discussion on Cost Accounting

and Management Accounting in this section). In the area represented by the narrow view of cost accounting, the more recent developments are in the area of control accounting. Dickey emphasizes the view that "cost control is people" (Cost and Management, vol. 31). He states:

It seems advisable to provide some specific training in human relations for those who administer cost controls. An individual who had no training in accounting or in production techniques would seem an unlikely person to put in charge of a budget. Since the aim of control devices is to influence the action of people, it seems equally important to include in the training of administrators of cost control programs some study of the art of influencing people.

A number of companies are now giving more attention to this aspect of cost control.

Effect of Automation. As the era of greater automation in the factory opens, there is speculation as to what effect this will have on cost accounting. Kenyon (The Cost Accountant, vol. 36) expresses the opinion that automation will result in smoother production processes, with fewer significant deviations from standard, and therefore easier cost control. **Service departments** will increase in importance, with a corresponding emphasis on control of costs therein. Kenyon believes that greater importance will be attached to the planning of operations and the choosing of the most advantageous course of action, and that the cost accountant should be prepared to make a substantial contribution in these areas.

Conditions in Individual Companies. In discussing the developments in cost accounting within any period, the wide disparity in the **accounting systems** actually used must be kept in mind. Various studies made from time to time of companies which failed have shown that a high percentage of such companies had almost no accounting records or very inadequate accounting systems, and it is claimed that this deficiency has been an important cause of failure. This means that the accounting advances described in the literature and adopted by many companies are ignored by other firms.

With several million accounting entities in the United States, and with no complete report available on the accounting practices of these organizations, it is difficult to know the actual condition of cost accounting systems in American industry as a whole. Probably the largest survey is that reported by the Office of Price Administration (A Report on Cost Accounting in Industry). This report summarizes some of the **cost accounting practices** of approximately 187,370 companies, of which it was estimated that only about 29,046 (or approximately 15 percent) had costs on a product basis and that at that time probably not more than 25 percent of total American production was covered by cost accounting systems showing cost on a product basis. After completing this report for the OPA, Black and Eversole summarize (Handbook of Cost Accounting Methods, Lasser, ed.) the condition of cost accounting in American industry in these words:

Our general conclusion on cost practices would be that labor and materials are rather well handled in an accounting sense; that the distribution of factory overhead leaves much to be desired; and that distribution cost accounting is more a matter of conversation than practice.

Although progress has been made in the cost accounting practices of many firms since the time of this survey, there is still room for improvement in the cost accounting practices of many companies.

Cost Accounting in the Federal Government. In describing the purposes of cost accounting in a governmental unit, Mikesell (Governmental Accounting) says:

Cost accounting is virtually indispensable in any scheme or plan to judge the efficiency of government. Comparisons based upon generalities may be not only erroneous but even misleading. In addition to its use in determining efficiency, and possibly more important, cost accounting is a tool for promoting it.

In a discussion of the role of cost accounting in governmental units in general, the Accountants' Handbook (Wixon, ed.) refers to the increasing adoption of cost accounting procedures within the accounting system of the federal government.

The growing size and complexity of the operations of the federal government during and after World War II called for more effective **financial planning and control** measures than those provided by the Budget and Accounting Act of 1921. This had emphasized the handling of cash receipts and disbursements and the prevention of the overobligation or overexpenditure of appropriations and allotments. The Joint Program to Improve Accounting in the Federal Government, inaugurated by the Comptroller General, the Secretary of the Treasury, and the Director of the Bureau of the Budget (1947), is one of the movements that has contributed to improved accounting systems and procedures.

The work of the first Hoover Commission led to the Budget and Accounting Procedures Act (1950) which called for certain improvements in the accounting and budgetary systems and permitted more effective financial management. The second Hoover Commission's report (Budget and Accounting) made a number of important recommendations, most of which were incorporated in Public Law 863 (84th Congress), which directs each executive agency to maintain accounts on an **accrual basis.** This means that the funds appropriated each year should closely parallel the goods and services received by the agency, and thus permits a greater degree of control than had been present under the former system. Public Law 863 also directs that, at such times as may be practical, the budget document should contain information on **program costs** and accomplishments. It further requires that appropriation requests be developed from **cost-based budgets,** which were recommended by the AAA Committee on Governmental Accounting (Accounting Review, vol. 33). These cost-based budgets are to be used by the executive agencies in their operations and in allotting appropriations. Recently substantial progress has been made in putting the appropriation requests of many of the departments of the federal government on a cost basis.

COST ACCOUNTING ORGANIZATIONS. The role and stature of cost accounting in modern economic society is mirrored in the activities of several accounting organizations formed for research, education, and professional advancement in areas in which cost accounting functions. In addition the development of cost accounting is reflected in the growth of those associations interested in areas of concern to cost accountants.

National Association of Accountants. Founded in 1919 as the **National Association of Cost Accountants,** the National Association of Accountants has been a leader in the development of cost accounting. It has contributed greatly to the advancement of cost accounting from the procedural aspects of the field in years past to the present dynamic management accounting discipline useful in many areas of management and administration.

Membership in NAA is composed of men and women representing a wide variety of occupations in nearly every field of economic endeavor. The common

element drawing the membership together is an interest in the use of accounting in management. Some authorities have suggested that cost accounting is management accounting, and the change in name of the Association on July 1, 1957, to National Association of Accountants reflects this view in part.

Services which the Association provides to its membership include (1) the monthly NAA Bulletin which contains articles on a wide range of accounting subjects, reviews of current accounting literature, notes on new developments in the accounting field, and addresses at the Annual Conference; (2) the results of a continuous program of research in accounting, published in a series of bulletins (see Acknowledgments); (3) specific information to individual members on special problems; (4) opportunities for exchange of information with other accountants at local, regional, and national conferences; (5) discussions, plant visitations, and forum programs under the supervision of local chapter organizations; and (6) general information on accounting developments in news letters and the NAA Bulletin.

The National Association of Accountants represents the largest organization of accountants in the world. Typical subjects of concern to this group of accountants include (1) profit planning, (2) measuring profit by product lines, (3) budgeting for the smaller company, (4) using the return on capital concept, (5) inventory management, and (6) cost accounting systems for different industries, and (7) a host of related areas.

Controllers Institute of America. Organized in 1931, the Controllers Institute is open to those who perform the controllership function. The Institute's official monthly magazine, The Controller, contains many articles of interest to cost accountants. To further its research objective, the Institute has established a separate research organization known as the Controllership Foundation, which has issued several publications in the area of cost accounting. Subjects of particular interest to controllers include (1) control by budget, (2) analysis and control of cash flow, (3) automation, and (4) operations research. The concept of the function of **controllership,** as developed by the Controllers Institute, and the relations of the controller to the cost accounting department are discussed in the section on the Cost Accounting Department.

American Accounting Association. Next to the National Association of Accountants, the American Accounting Association, founded in 1916 as the American Association of University Instructors in Accounting, appears to be the organization most interested in the over-all development of cost accounting. Essentially the AAA is an association open to anyone interested in accounting. It is, however, particularly interested in accounting theory, in research, and in all phases of accounting education. The quarterly publication of the Association, The Accounting Review, was started in 1926. The Association holds an annual meeting. Topics of interest to this Association cover the entire field of accounting, but cost accounting is well represented in its publications, committee activities, and annual meeting papers. In terms of contribution to cost accounting, the American Accounting Association has encouraged the development and expansion of cost accounting theory.

American Institute of CPA's. The AICPA is the one national organization of certified public accountants. It was founded in 1887 as the American Association of Public Accountants and was known as the American Institute of Accountants from 1917 to June, 1957, when the present name was adopted. Its monthly magazine, The Journal of Accountancy, was first published in November, 1905. The

Institute's membership has grown substantially in recent years, reflecting the rapid growth of the public accounting profession. The Institute includes in its membership a large number of CPA's engaged in industrial, commercial, and governmental accounting and teaching. Therefore, while the Institute's main interest is in the area of public accounting, its research and its publications include many topics of interest to cost accountants. Its Accounting Research Bulletins, begun in 1939, have had great influence in developing and winning adherence to accounting principles and sound procedures. Its Accounting Terminology Bulletins and its annual publication, Accounting Trends and Techniques, which analyzes the accounting aspects of financial reports published annually by 600 well-known American industrial companies, are valuable to persons in industrial accounting.

Institute of Internal Auditors. This organization was formed in 1941 and is composed of those interested in internal auditing. The Research Committee of this Institute defines **internal auditing** as:

> The independent appraisal activity within an organization for the review of the accounting, financial, and other operations as a basis for protective and constructive service to management. It is a type of control which functions by measuring and evaluating the effectiveness of other types of control. It deals primarily with accounting and financial matters, but it may also properly deal with matters of an operating nature.

The official magazine of the Institute is The Internal Auditor, published quarterly.

National Machine Accountants Association. The NMAA has had a very rapid growth since its founding in 1951. According to Gerighty (The Controller, vol. 25) the Association is interested in education in such areas as (1) machine accounting and electronic data processing programs, (2) planning and managing punched-card systems, (3) theory and application of digital computer systems, (4) application of automation to office systems and procedures, (5) machine wiring and principles, (6) key-punch training, and related topics. The Association publishes a monthly magazine, Journal of Machine Accounting: Data Processing Systems and Management.

Controllers Congress of NRMA. Organized in 1920, this Congress in the National Retail Merchants Association has directed its attention to the cost accounting problems of department stores. It has issued a suggested accounting system for department stores of various sizes in which the **contribution theory** of departmental costing is advocated as most appropriate.

Systems & Procedures Association of America. The SPA, founded in 1944, is primarily interested in systems organization and procedures and related management work. It publishes its annual meeting papers, various special studies by its research and education committees, and its official magazine, Systems and Procedures.

Other Associations. The **National Society of Business Budgeting** is concerned with budgeting and necessarily deals with subjects of interest to the cost accounting field. The **Railway Accounting Officers Association** is an association of accountants engaged in railroad accounting. As an organized body it advises the Interstate Commerce Commission on railroad accounting problems in order to improve railway accounting systems.

The **Municipal Finance Officers Association** has done much to improve cost accounting procedures in the area of local and state governments. The **National Association of Bank Auditors and Controllers** has been especially important

in the development of cost accounting procedures and techniques for application by banks.

The **American Woman's Society of Certified Public Accountants,** founded in 1933, and its affiliate organization, the **American Society of Women Accountants,** founded in 1933, are primarily concerned with the problems of women in the profession of accountancy. Many of the members are in industrial, commercial, and institutional accounting. Since 1938 these two organizations have jointly published the bimonthly magazine, The Woman C.P.A.

In addition, the **Institute of Newspaper Controllers and Finance Officers,** the **National Association of Hotel Accountants,** and the **Federal Government Accountants Association,** as well as other related associations, have all contributed to developments in the field of cost accounting.

Cost Accounting Concepts and Principles

NATURE OF COST ACCOUNTING CONCEPTS. Efforts to develop standards or principles for public accounting reports to stockholders resulted in suggestions that similar standards or principles should be developed for cost accounting reports to management. Well in advance of this demand, however, efforts had been directed to the development of improved procedures for providing cost accounting reports to management. Articles and organized research have for a long time been concerned with improvement in **cost accounting procedures.** It was not until 1947, however, that an organized effort was made to develop **cost accounting principles** by a Committee on Statement of Cost Accounting Principles of the American Accounting Association. Upon completion of their study and discussion, Read, one of the Committee members, reported (The Accounting Review, vol. 23):

> It was felt by the Committee that the use of the word "principle" might well be avoided at this stage of the development. In general the term "principle" seems to carry a connotation of a false degree of certainty, or something "in the nature of things" that does not exist in the accounting field. The terms "concepts" and "standards" seem to be much more meaningful. The art of accounting, including cost accounting, consists primarily of accounting methods which may be described as procedures or practices. However, a comprehensive statement of cost accounting necessitates that one look behind the accounting methods and see upon what ground the whole system of cost accounting is constructed.
>
> It is at this point that concepts come into the picture. Since cost accounting as well as all accounting is man-made, it is well to look into the ideas of those persons designing cost accounting systems to see if it can be determined what motives they had in mind.

Derivation of Concepts. Whatever the term used, it appears the Committee's objective is to state the basic ideas behind the cost accounting rules and procedures applied in practice. These concepts or principles may be developed either deductively or inductively. **Deductively derived concepts** represent those generalized statements developed by reasoning from a set of assumptions as to what is desirable. They serve as guides for the application of specific cost accounting procedures. **Inductively derived concepts** are those generalized statements developed by gathering together under one statement a number of empirically observed rules and procedures. Littleton's statement (Structure of Accounting Theory) that "accounting principles can be derived inductively out of accounting actions which are clearly relevant to known accounting objectives," supports the view that principles or concepts can be developed inductively.

Generalized Statements. There is some acceptance of the view that it is possible to set forth a series of interrelated generalized statements which will constitute a **statement of principles, concepts, or standards.** These generalized statements serve as guides to action in applying procedures to a specific situation. In the area of cost accounting, it has been assumed, however, that because cost accounting procedures were used for so many different purposes, it was not possible to set forth any generalized statement without reference to the objective or purpose to be accomplished. The idea underlying this thinking was expressed by Bridgman (The Logic of Modern Physics) in the statement that "the proper definition of a concept is not in terms of its properties but in terms of actual operations."

Significance of Objectives. As a consequence of this situation, it is now being recognized that any **statement of cost accounting concepts** will have to be composed of more than one set of concepts. Different sets of concepts would be appropriate for the different purposes for which the cost information is to be used.

According to some authorities, a statement of cost accounting concepts could be developed by resolving the function or objectives of cost accounting into the three areas of aiding in **planning, control,** and **income determination.** Different concepts would be developed for each of the three objectives, and the three sets of concepts would represent a statement of cost concepts or standards to be used as guides in the application of cost accounting rules and procedures to specific situations.

Other authorities feel that it is not possible to set forth a statement of cost accounting concepts. According to this view, it is necessary to develop more satisfactory **rules** and **procedures** for specific situations. Later, as these improved rules and procedures are more fully developed, it may be possible to draw them together into statements of systems or of concepts or standards.

DEVELOPMENT OF COST ACCOUNTING CONCEPTS. Efforts to develop cost accounting concepts and standards are the result of work by professional societies, government agencies, or individuals.

Work of the NAA. The National Association of Accountants has worked more in the direction of improving **cost accounting procedures and practices** than toward the development of general concepts. Their research studies have done much to crystallize cost accounting thinking in specific areas. The Research Report Series issued by the Association has contributed greatly to the development of cost accounting concepts. (These reports are listed in the Acknowledgments.)

It seems to be the policy of NAA to continue issuing bulletins on specific subjects. As yet no attempt has been made by this association to provide an over-all statement of cost concepts of standards. The work of the **Controllers Institute of America** has been confined to the publication of books and pamphlets on specific topics. These have been related largely to the planning and control areas.

Work of the AAA. The Committee on Cost Concepts and Standards of the American Accounting Association has issued a series of articles on the general subject of cost accounting concepts. This was the first organized attempt to provide an over-all conceptual framework of the problem of setting forth a statement of cost concepts. Dixon (Accounting Review, vol. 23) indicates that the Committee on Cost Concepts and Standards believed that the two principal, continuous services of cost accounting are the **minimization of costs** and the matching of

costs with revenues in the **determination of income**; the third major function is one of furnishing **special services**, solving special problems as they come up.

The discussion of these three areas supports the view that different costs and different procedures and techniques are appropriate for the three objectives of cost accounting.

STATEMENT OF COST CONCEPTS. The first statement of cost concepts underlying reports for management purposes was developed by the 1955 Committee on Cost Concepts and Standards, Tentative Statement of Cost Concepts Underlying Reports for Management Purposes (The Accounting Review, vol. 31). This report sets up a conceptual framework for cost accounting concepts which is useful to management for planning and control decisions.

Cost Concepts for Planning. The Committee classifies all business planning as either project planning or period planning, depending upon its purpose. **Project planning** is defined as:

> . . . the process whereby management, confronted by a specific problem, evaluates each alternative in order to arrive at a decision as to the course of future action.

The Committee characterizes costs for project planning as "estimates of future value releases anticipated as a result of adopting any one of the alternative courses of future action considered by the company." Since planning normally involves a comparison of the estimated future costs of each of the alternative solutions to the project, such future costs may be expressed as the cost of the **differential services** required for each alternative. As a result the development of the future cost estimate for each of the alternative solutions requires an estimate of only those costs not common to all the alternative solutions. In a broad sense only the **differential costs** of the alternatives need to be compared.

Conceptually, measurement of the cost of the differential services required for each alternative is somewhat involved. For such measurements the Committee states that a distinction should be made:

> . . . between differential services on hand, or for which the company is irrevocably committed, at the beginning of the planning period, and those to be acquired within that period; between those expected to be entirely consumed within that period and those of which a residual is expected to remain at the end of the period; and between those which management considers replacing and those which it does not.

In terms of these distinctions, the Committee suggests the following bases for measuring costs to be used in project planning:

1. Differential services to be acquired and fully consumed during the project period, for which the basis for estimating future costs is the expected future outlay of cash, or its equivalent.
2. Differential services to be acquired and partially consumed during the project period, for which the basis for estimating future costs is the future outlay of cash, or its equivalent, required for their acquisition, less the estimated cash equivalent valuation of services remaining at the end of the period.
3. Differential services on hand at the beginning of the period which are expected to be fully or partially consumed, for which the basis for estimating future costs is their cash equivalent valuation at the time of utilization.

The Committee points out that all differential costs must be adjusted when the period of project planning is long, in order to take account of time and risk variations. The **discounting procedure** is recommended as the most satisfactory method for doing this.

Period planning is defined as:

. . . the process whereby management systematically develops an acceptable set of plans for the total future activities of the enterprise, or some functional subdivision thereof, for a specified period of time.

Period planning, normally covering a period of one year, usually results in an over-all **budget.** As opposed to project planning, period planning involves anticipated costs and revenues for income determination purposes or other rather complete cost accumulations rather than differential costs. Estimated future costs are built up by areas of responsibility and function which must be performed if policies and plans are to be followed. **Historical cost** and **variable cost** concepts are utilized in this estimating procedure. The Committee observes that:

Period planning provides for an over-all evaluation by top level management of a master plan prepared in accordance with major policies and restrictions previously imposed by it. It is constructed as a reviewing device rather than as a means of providing the basis for the preparation of another master plan or revision of the plan under consideration. Changes in planned combinations of activities, induced by apparently unsatisfactory total results presented in period planning, should be re-examined in the light of the proper concepts of project planning cost before they are effected.

Cost Concepts for Control. In the section directed to cost concepts appropriate for the control function, the AAA Committee on Cost Concepts and Standards (The Accounting Review, vol. 31) recognizes three main purposes for which cost data may be useful in the control of current operations: (1) as a communication device, (2) as a device for motivation, and (3) as an appraisal device.

As a **communication device,** cost data help management to direct individuals within the organization to carry out its plans, including the objectives management wishes to achieve, the methods to be used to achieve these objectives, and the limitations to which the organization is expected to adhere. The Committee states that:

In this use, costs may be classified in terms of activity, personal responsibility, or types of services to be used in carrying out the adopted plans. While the budget is one form of communicating information of this type, it is, of course, not the sole means, and rarely is it as important as other communication devices, particularly oral instructions.

As a **device for motivation,** if cost data are properly constructed and if accompanied by proper management action and attitude, they may serve as significant incentives for attaining planned objectives. Some guides which the Committee suggests for determining the appropriate costs to be charged to a **person or responsibility center** are:

1. If the person has authority over both the acquisition and the use of the services, he should be charged with the cost of such services.
2. If the person can significantly influence the amount of cost through his own action, he may be charged with such costs.
3. Even if the person cannot significantly influence the amount of cost through his own direct action, he may be charged with those elements with which the management desires him to be concerned so that he will help to influence those who are responsible.

The Committee indicates that the setting of costs limits restricting service acquisition or utilization for a specified activity may be a useful method of limitation, especially for costs in such areas as research personnel and other staff func-

tions where it is difficult to relate costs to specific performance. The Committee points out that the bases of cost measurement selected should be consistent with the type of motivation desired and that the reporting of costs for which any person is held responsible should be consistent as to the basis for measuring any given cost factor, the types of cost factors included in such reports, and the person who is held responsible for a given cost factor.

As an appraisal device, the Committee distinguishes two types of preparation of costs for control purposes: (1) before the fact (standard or budgets) and (2) after the fact (performance reports). While performance reports are useful to avoid repeating previous mistakes, the knowledge that appraisals are being made may provide a strong incentive for good performance. The performance reports also assist later management planning.

The Committee suggests adjustments to **historical cost data** to provide data more useful in planning and control than that provided by costs used in determining income. The Committee does not attempt to set forth distinctive cost accounting concepts useful in determining income.

Efforts by others to formulate cost accounting concepts include reports of special committees, such as the Report to the Federal Trade Commission by the Advisory Committee on Cost Justification, and reports by a variety of individuals in the accounting and management fields.

Limitations of Cost Accounting Procedures

LACK OF CONFORMITY. Possibly the greatest limitation of cost accounting is the failure of those in practice to conform to any **uniform procedures.** As a result, different cost amounts are given the same title but computed on such a different basis as to have little consistency of meaning. This limitation is especially acute in those areas of cost accounting beyond the recorded historical cost data. In a sense the limitations are due to failure to recognize that different costs are needed for different purposes and because of the difficulty of measuring desirable amounts. Limitations of **historical cost accounting procedures** are often cited by authorities in the field. Typical of these reservations is that expressed in the Report to the Federal Trade Commission by the Advisory Committee on Cost Justification to the effect that:

> Cost accounting is not and can never become an exact science because of the inherent element of judgment. Despite the prescription of uniform and detailed cost accounting procedures, two equally competent cost accountants may obtain different results from the same data. For this reason all cost accounting and cost analysis results should be accepted as reasonable approaches to accuracy and not as precise measurements.

EXTENT OF JOINT COSTS. Perhaps the most all-inclusive limitation of historical cost accounting procedures is the extent of joint costs. Vatter (The Accounting Review, vol. 20) points out that while all costs are more or less interwoven, many costs are joint at the point of their incurrence as well as in their association with various costing units. Since production involves the formation of a new combination from various kinds of economic services, Vatter states that:

> The service-product is often very different from any of the component items; the services measured by input costs are not contributory to the product but complementary to each other. Appropriations of services, whether measured by asset expirations, accruals, or disbursements, do not stand individually and alone in the process of assimilation, for the way in which the service factors are combined is at least as

important as the nature of the specific items themselves. Changes in the service potentialities of any factor may entail alteration in the product; it is frequently true that the absence or the alteration of a single factor may make the continuance of operations difficult if not impossible. In this situation, costs are often incurred because other costs have been incurred; one item of outlay trails others along with it, either concomitantly or in sequence.

Other aspects of this jointness of costs include:

1. The cost of one factor of production may be changed by alterations in the other factors. For example, the labor cost of an operation may be increased or decreased by changing the quality of materials, improving the machine layout, and so forth.
2. Co-product production.
3. The assignment of costs to periods of time.

For a further discussion of the problems of joint costs, see the section on Joint Costs.

OTHER FACTORS. Goetz (Management Planning and Control) points to a serious limitation of cost accounting procedures in conventional product costing in the following terms:

> Traditionally, the double-entry system has been limited to historical data and to a single set of values. Arguments may arise as to whether the truth is revealed by first-in, first-out or by last-in, first-out computations. . . . Nowhere in traditional legal-financial accounting does one find explicit insistence on the dependence of values on purposes and situations except in such gross instances as the preparation of a statement of liquidation or the sale of an owner's equity.

Still another limitation sometimes attributed to cost accounting procedure is the existence of **noncost factors,** especially the factor of **risk.** Thus cost accounting procedures may not be so fully informative as management may wish them to be. Other procedures of cost accounting, such as a breakdown of costs into **fixed** and **variable elements,** may suggest an accuracy which may be misleading. For a discussion of the difficulties of dividing costs into fixed and variable components, see the section on the Accumulation of Manufacturing Overhead.

Koontz and O'Donnell (Principles of Management) point out in an over-all view of the shortcomings of cost accounting techniques that:

> The techniques employed by accountants in accumulating and reporting cost information has been a source of criticism. Although problems exist in the accurate accumulation of direct labor and materials cost, largely because of the need for correct and complete basic records of time and materials, the principal criticisms are aimed at the many arbitrary allocations of common costs. . . . In so doing, detailed costs, often carried out to several decimal places, tend to rest upon broad and sometimes elaborate assumptions that may make accuracy an illusion.

Koontz and O'Donnell comment that cost accountants are well aware of such errors and arbitrary allocations but assert that more accurate data or allocations cannot be justified because of the additional expense. They conclude that the benefits of more accurate data for decision making should be weighed against such expense and that those to whom cost data are reported should be informed as to the accuracy of the data, particularly where it relates to production and where allocation of the costs has been arbitrary. These are constructive suggestions for overcoming some of the limitations of cost accounting procedures.

SECTION

COST CLASSIFICATIONS

CONTENTS

CONTENTS (*Continued*)

SECTION 2

COST CLASSIFICATIONS

Classification by Purposes Served

MEANING OF COST CLASSIFICATION. Classification is the process of grouping like facts under a common designation on the basis of similarities of nature, attributes, or relations. A Research Project Committee of the National Association of Accountants (Research Series No. 34, Classification and Coding Techniques to Facilitate Accounting Operations) states: "Classification is necessary to bring out the significance of information and is an essential step in the summarization of details." The committee defines classification as: "The identification of each item and the systematic placement of like items together according to their common features. Items grouped together under common heads are further defined according to their fundamental differences."

Littleton (Structure of Accounting Theory) states:

> The operation of an accounting system falls into two major processes: The first accomplishes the conversion of transaction events into account debits and credits. . . . The second operating process deals with the rules for revising the data produced by initial classification. It is a process of reclassification.

In cost accounting this second process is carried on extensively, and data in debit-credit form as well as other information are rearranged according to management's needs. Lang–McFarland–Schiff (Cost Accounting) describe the classification of costs as follows:

> In the process of cost accounting, costs are arranged and rearranged in various classifications, each of which helps to answer some of the questions frequently asked about costs. The same costs thus appear in several different classifications, depending on the purposes which the costs are to serve. For different purposes different kinds of information are required. Hence, costs must be so arranged and classified that they can be combined in different ways to serve different purposes.

NAA Research Series No. 7 (NAA Bulletin, vol. 27), in discussing the uses and classifications of costs, states: "Cost accounting involves both analyses and syntheses. It involves breaking down the stream of costs into its elements and the grouping of these various elements into the combinations best suited to the purpose in hand. In these processes numerous bases for classification are used." The Tentative Statement of Cost Concepts Underlying Reports for Management Purposes by the AAA Committee on Cost Concepts and Standards (Accounting Review, vol. 31) also emphasizes the importance of purpose as a basis of cost classification:

> Cost is classified normally in terms of a managerial objective. Its presentation normally requires subclassification. Such subclassification may be according to functional lines, areas of responsibility, the nature of the cost elements, or some other useful

breakdown. The appropriate subclassification depends upon the uses to be made of the cost report.

INCOME DETERMINATION AND INVENTORY COSTING. A major objective of the accountant is the determination of periodic net income. Consequently costs must be gathered and classified so as to distinguish between those which apply to **current revenues** and those which should be carried into future periods as some form of **asset**. This gives rise to a variety of cost subclassifications, such as capital and revenue charges, product and period costs, cost of goods sold and inventory cost, direct and indirect costs, fixed and variable costs, and production department and service department costs. These are important to periodic income determination and inventory cost assignment. Except for the fixed-variable cost classifications, however, they have considerably less bearing on problems of cost control and special decisions of management involving alternative courses of action.

In Fig. 1, NAA Research Series No. 7 (NAA Bulletin, vol. 27) illustrates the way in which the first three classifications listed in the preceding paragraph help

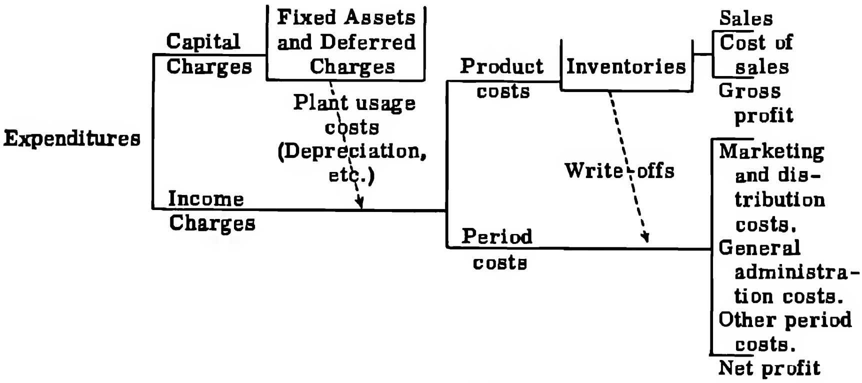


Fig. 1. Separation of costs—current revenues and deferred costs.

separate costs which are applicable to current revenues from costs to be deferred as fixed assets, deferred charges, and inventories.

COST CONTROL. Another major purpose of cost accounting is to provide data for control over cost. To help management achieve control, the accountant follows management's interests by classifying costs into **controllable** and **noncontrollable** and according to areas of managerial responsibility such as divisional, departmental, cost center, and operational. Ordinarily the higher the level of responsibility, the more summarized the cost classification; the lower, the more detailed. The production manager, for example, is interested in summaries of cost by controllable elements, by departments, and by cost centers. Cost center supervisors, on the other hand, will be concerned with the details of controllable costs under their supervision, such as specific labor and material costs of a particular operation. Where cost control is the immediate end in view, classifications and reporting of cost will be arranged to highlight deviations from past, budgeted, or standard cost.

SPECIAL DECISIONS. Problems of product costing and cost control have given rise to a great number of commonly accepted cost classifications. A third

area of cost accounting usefulness lies in providing management with classifications designed to help solve a variety of problems not ordinarily associated with periodic income determination and cost control. In such instances, costs are classified according to their relevance to a decision, and as the need to make different decisions arises, costs will be correspondingly reclassified. To meet this newly recognized objective of providing costs for special decisions of management, increased emphasis is being placed on the **fixed and variable cost** classifications, as well as opportunity, out-of-pocket, differential, and sunk costs.

Capital vs. Revenue Expenditures

DEFINITION. Accountants often use the terms "capital" and "revenue expenditures" as means of classifying charges of a fiscal period. Kohler (A Dictionary for Accountants) clearly distinguishes between the two types when he defines capital expenditure as "an expenditure intended to benefit future periods, in contrast to a revenue expenditure which benefits a current period." Sometimes too much importance is placed upon the account that is charged at the incurrence of the expenditure, as though the charge could not be transferred later to another account.

Essentially the distinction sought would be better posed were the question raised as capital versus revenue charges, with the word "charge" having reference to the final disposition of an expenditure or its equivalent. Thus, if the distinction refers to the problem of recognizing a value contribution not extending beyond a current period, an expenditure may more properly be referred to as a **revenue charge**, regardless of the initial account debited in the accounting records. By the same token, were an expenditure to represent a value contribution extending beyond a current period, it might properly be referred to as a **capital charge**, again notwithstanding the initial account debited. This appears to be the more useful interpretation of the capital-revenue expenditure classifications.

The "center of gravity" in accounting lies in determining effectively the periodic results of operations. Use of the terms "capital" and "revenue expenditures" raises the question with regard to each expenditure: Does this contribute to current or future revenues? If it contributes to present revenues, is a nominal account finally charged by the close of the period? If it contributes to future revenues, it should be charged to some type of asset account.

EXPENDITURES RELATING TO FIXED ASSETS. The capital-revenue expenditure distinction normally relates to **plant or fixed asset accounting.** It is with reference to plant items that the capital-revenue expenditure classifications assume importance, for it is in connection with fixed assets that the more significant and more complex problems concerning the distinction arise. The guiding rule of value contribution to the current period as opposed to value contribution to future periods becomes difficult to apply and often subject to question. Paton and Paton (Asset Accounting) include the following topics under asset accounting:

1. Acquisitions, initial and replacement.
2. Improvements.
3. Reconstruction and alteration.
4. Additions.
5. Rehabilitation.
6. Repairs, maintenance, and major overhauls.
7. Retirements.

Depreciation accounting presents one aspect of the capital-revenue classification problem wherein items previously capitalized become recognized as revenue charges or become capitalized as a cost of a new asset under construction. For a discussion of depreciation accounting see the Accountants' Handbook (Wixon, ed.).

Replacements and Additions. Initial acquisitions involve increasing the sum total of investment in plant. Replacements involve the acquisition of new assets to take the place of assets retired. Such replacements may take the form of acquisitions of whole units of plant or major parts contained in units of plant. They may come in the form of an improvement or betterment. An **improvement** is defined by Paton and Paton (Asset Accounting) as: "any alteration or structural change in a unit of plant property which results in greater durability or increased productivity or efficiency." **Reconstructions and alterations** are in the nature of improvements.

Additions represent extensions to existing equipment. In the case of an addition, no retirement takes place nor is there any change in the original structure. The original structure remains, but an added mechanical part has been connected to it. Addition is also used in connection with the acquisition of equipment not taking the place of equipment retired. Paton and Paton (Asset Accounting) refer to a **rehabilitation** as the process of putting into usable shape the assets acquired in a worn and run-down condition. The restoration of equipment run-down through operations is termed a **major overhaul.** Since the cost of such restoration extends the life of a fixed asset and is not in the nature of an acquisition, replacement, improvement, or addition, its cost is commonly charged to Allowance for Depreciation. This has the effect of increasing the length of time over which depreciation is taken.

Replacements and improvements commonly involve the retirement of assets in whole or in part. Where feasible the book value of the asset or portion of the asset retired should be removed from the accounts, and the value increase involved should be charged to the proper **plant asset account.**

Maintenance and Replacements. The determination of the borderline between ordinary maintenance and repairs on the one hand and replacements and major overhauls on the other is a problem whose solution rests upon the significance of the charge in question and the frequency with which it or like items re-occur. According to Devine (Handbook of Modern Accounting Theory, Backer, ed.):

> The accountant usually selects the depreciating unit on the basis of convenience and sets the life, and therefore the rate, according to his estimates for the entire operating unit with a planned maintenance program. In a general way the replacements of certain parts of the unit must be anticipated in order to set the estimated life. The accountant then assumes that such replacements are "ordinary" and must be charged to expense in the period in which the cost is incurred. . . .
>
> The usual distinction between ordinary repairs and replacements—those that are charged against current income—and extraordinary items is that the latter are presumed to increase the value of the original unit or increase its life. It should be clear that an extension of life is important only to the extent that value is increased. The test of value increase appears to be sufficient, and adding useful life is only one way in which total value may be increased.

EXPENDITURES TREATED AS DEFERRED CHARGES. The deferred charges section of the balance sheet has long represented a section of doubtful validity, for in essence all capital expenditures including the purchase

or creation of inventories represent charges to be deferred and assessed, at least in part, against the revenues of subsequent periods.

Moonitz and Staehling (Accounting, An Analysis of Its Problems, vol. I) state:

> All outlays or commitments for operating assets, such as inventories, plant, and equipment, represent outlays made for productive factors in advance of their use in operations. Accordingly, inventories, plant, and equipment are often referred to as "deferred charges to operations," since the ultimate disposition of the charges to those accounts is, in the usual case, a transfer to profit and loss.

Over the years the **deferred charges classification** has been under steady attack and consequently has become narrowed considerably in scope. AICPA Accounting Research Bulletin No. 43 recommends that a number of prepaid expense items previously treated as deferred charges, "such as insurance, interest, rents, taxes, unused royalties, current paid advertising service not yet received, and operating supplies . . ." be shown under current assets.

Costs of Rearrangement. A generally recognized definition of the cost of a fixed asset is its net invoice cost plus transportation and installation costs. **Installation cost** ordinarily refers to the cost of placing an asset in a position ready for use. Costs incurred in the moving of an asset to a place different from its original installation may be interpreted as the cost of a managerial error with respect to the original installation or as a type of improvement. In any event only the excess of the rearrangement or removal cost over the original installation cost ought to be capitalized, the balance to be charged against current revenues or retained earnings, depending upon whether the current operating or clean surplus concept of the income account is held. AICPA Accounting Research Bulletin No. 43 lists as applicable to the deferred charges classification: "Costs of rearrangement of factory layout or removal to a new location . . ."

EXPENDITURES INCURRED DURING CONSTRUCTION. Expenditures incurred in connection with depreciable assets during a period of construction or "getting ready" for operations, such as interest paid on borrowed money during the construction period, insurance, and taxes, are properly capitalized. With the advent of operations, current expenditures for such items become charges against current operating revenues.

COSTS INCURRED DURING STRIKE OR TEMPORARY SHUTDOWN. When a shutdown takes place because of a strike or disaster, an interesting question arises concerning the treatment of costs incurred during this period. On the one hand, every business is susceptible to certain physical and human hazards which over the long run add to the cost of doing business. From this point of view each fiscal period ought to bear a proportionate share of such costs. On the other hand, individual businesses may or may not face identical or similar hazards. Consequently, when the costs of a strike or disaster are met, they may be interpreted as either catastrophic losses which render no particular benefits to the present or future or costs incurred to obtain revenues anticipated in future periods. If the latter point of view is adhered to, there is some justification for deferring such costs to future periods.

The AICPA Committee on Accounting Procedure (Accounting Research Bulletin No. 43) takes the position that:

> Material losses of a type not usually insured against, such as those resulting from wars, riots, earthquakes, and similar calamities or catastrophes, except where such losses are a recurrent hazard of the business . . . may be excluded from the deter-

mination of net income for the year, and they should be excluded when their inclusion would impair the significance of net income so that misleading inferences might be drawn therefrom.

The Committee recommends charging such costs to the surplus account.

EXPENDITURES CHARGED AGAINST REVENUES. In the early development of accounting, expenditures generally were charged against revenues of the year in which the expenditures took place. With the development of accrual accounting and cost accounting, accountants attempted to distinguish between those costs which contributed to current revenues and those which made a contribution in whole or in part to future revenues. On this subject the AAA Committee on Accounting Concepts and Standards (Accounting and Reporting Standards for Corporate Financial Statements) states:

> The realized net income of an enterprise measures its effectiveness as an operating unit and is the change in its net assets arising out of (a) the excess or deficiency of revenue compared with related expired cost, and (b) other gains or losses to the enterprise from sales, exchanges, or other conversions of assets . . .
>
> Expired costs are those having no discernible benefit to future operations. They may be classified as "expense" or "loss." Expense is the expired cost, directly or indirectly related to a given fiscal period, of the flow of goods or services into the market and related operations. Loss is expired cost not beneficial to the revenue-producing activities of the enterprise.

Research and Development Costs

DEFINITION. NAA Research Series No. 29 (NAA Bulletin vol. 36) states:

> Research is defined in one company's organization manual as "a planned program directed toward a search for new facts, new applications of accepted facts, or new interpretations of available information." Development usually refers to the commercial application of knowledge gained by research. . . .
>
> Research and development comprises a variety of activities, including search for new products and new manufacturing processes; improvement of existing products, processes, and equipment; finding new uses for known products; solving technical problems arising in manufacture and application of products; and expanding general knowledge in basic scientific fields. . . .

In NAA Research Series No. 29, Moss' distinction between research and development costs and other costs (NAA Bulletin, vol. 35) is cited as follows:

Costs Included in Research.

1. Pure research, i.e., direct research or experimentation on general problems having no particular connection with the various products currently being manufactured by the plant.
2. Projects directing experimental or developmental effort toward the creation of new processes or new product or group of products to be manufactured by the plant. It is not intended that this should cover minor changes in which an existing product is replaced by, or improved by, another. Major developments resulting in an entirely new product or processes should be included, although they replace current products.
3. Projects directing experimental or developmental effort toward any improvement to a specific product already being manufactured by the plant or an improvement in existing process. This category would include any work necessary to correct production difficulties which existed in products or processes since the product was considered acceptable for the trade.

4. All further work beyond the developmental stage necessary to get a new product, model, or item of equipment ready for normal production and sale.
5. Projects for the purpose of designing and constructing new types of equipment or improvements to existing equipment which will be used in manufacturing processes and which will effect a change in any existing process in the plant.

Costs Not Included.

1. Technical advice or service rendered to production departments in order to help them out of difficulty or to carry on their normal operations.
2. Trouble shooting which is necessary to correct production difficulties which occur from time to time and which reduce normal standards of products or processes.
3. Any other work done which is essential to normal operations (in contrast to new work which can be done, or not done, depending upon the wishes of management).
4. The cost of producing experimentally, or otherwise, any material or article on the specific order of a customer when the material or article cannot reasonably be expected to lead to a product which will be added to the regular line.
5. Routine tests necessary for formal production procedure on a regular product.

CLASSIFICATION OF RESEARCH AND DEVELOPMENT COSTS. Research and development costs are classified according to the needs of a particular management. Common groupings of such costs are by nature of expense, research activity or function, responsibility, project, or product.

When research and development costs are classified according to the **nature of expense,** expenses such as salaries of technical personnel and others, specific materials used, and equipment expenses will be itemized. Classification by **activity** or **function** refers to the organization of expenses in such a way as to measure the costs of operating an experimental laboratory or testing center or amounts spent by other departments in connection with research and development. When research and development costs are classified by **responsibility,** interest is focused on the individuals or departments responsible for incurrence of these costs. Classification of research and development costs **by project** is illustrated in Fig. 2. by Keller (Management Accounting for Profit Control). The **project cost card** includes estimates taken from a project request form and provides for the accumulation of the actual costs of the project.

The NAA Committee on Research states in NAA Research Series No. 29 (NAA Bulletin, vol. 36) that when research and development costs are assigned to **products,** the purpose is:

1. To show how much is being spent for research and development on each product or product line.
2. To determine profit or loss by desired product classification.
3. To determine product costs for pricing purposes.

CAPITALIZING RESEARCH AND DEVELOPMENT COSTS. Almost all companies participating in the study upon which NAA Research Series No. 29 was based followed the practice of charging such costs to the period in which the costs were incurred. This was the case despite the fact that benefits derived from the incurrence of research and development costs are more likely to be received in fiscal periods subsequent to the incurrence of such costs.

It is a truism that often so-called unsuccessful projects make a contribution to later and successful ones, and from this point of view, losses suffered on unsuc-

Research Project Cost

Project: 57–173 Evaluation of additives for fiberboard stock

Supervisor: ____________________

Estimated Costs:

Chemists	500 hr. @ $12.00	$ 6,000.00
Technicians	1200 hr. @ 3.00	3,600 00
Pilot plant	200 hr. @ 8.00	1,600.00
Other personnel—none		
Equipment		2,000.00
Materials		
Outside services		
Other		
		$13,200.00

Actual Costs:

	Chem.	Tech.	Pilot Plant	Other
Hours reported				
Week of:				

	Equip.	Matl.	Outside Service	Other
Expenditures				
Date:				

Assignment of Costs:

	Estimate	Actual
Building products	$5.280	
Acoustical products	2.640	
Industrial products	5.280	

Fig. 2. Cost card for a research project.

cessful projects are a cost of those which later fulfill management's hopes and objectives. If those research and development costs with no bearing on the future are excluded, as for example, where it is definitely recognized that a mistake was made and a loss took place, the remaining research and development costs represent a continuing investment in profitable projects or products. Ideally these costs should be accumulated, and upon completion of a successful project or product. applicable charges should be withdrawn and either charged to expense or deferred to be amortized over periods of usefulness. Such a treatment of research and development costs, however, would assign the problem of accounting for research and development almost entirely to the realm of managerial subjective

judgment. At the present time, the practical problems of application appear to be too great to warrant following this procedure.

Keller (Management Accounting for Profit Control) refers to the practice of some companies in accounting for research and development costs which avoids carrying forward any research and development costs until a project is definitely ascertained to be successful:

They first charge them against operations of the year in which they are incurred. Then, when usable or patentable products or processes are developed, a reasonable value is assigned to them. This is set up as an intangible asset to be amortized over the estimated life of the product or process, and expense of the period is credited. The major disadvantage of this policy is that an unusual number of, or a few unusually valuable, successful completions in one year could substantially reduce cost and thus distort profits of that year.

Classification of Costs by Divisions

MEANING OF DIVISIONAL CLASSIFICATION. Costs are commonly classified according to the major activities or functions of a business. A tacit assumption underlying conventional income statements for manufacturing concerns is a threefold functional division of activities into production, distribution, and administration. A fourth functional division cited by many authors is that of finance.

PRODUCTION COSTS. Production costs refer to those costs incurred in fabricating and assembling units of product. Included among production costs are **material, labor,** and **manufacturing overhead costs** incurred to obtain inventories for sale and for stock. Excluded from production costs are costs of distributing the product, administrative costs which do not benefit productive operations, and general financing costs. Compilations of production costs are used for a variety of purposes: to assign costs to products, to make comparisons of actual costs with historical, budgeted, or standard costs, and for special analyses concerning a variety of managerial problems.

DISTRIBUTION COSTS. Distribution costs refer to those costs incurred to promote the sale and to facilitate the movement of goods into the hands of purchasers. The distribution cost classification includes costs of storing, packaging, transporting, selling, advertising, and applicable administrative expense. Excluded from distribution costs are manufacturing costs, administrative costs not benefiting distributive operations, and general financing costs. Except for the nonassignment of distribution costs to inventories, objectives of distribution costing are similar to those held for compilations of manufacturing costs. Differences in objectives held for distribution costs and manufacturing costs are matters of degree only. In **distribution cost analysis,** for example, considerable emphasis is placed upon directing expenditures into the most profitable channels. This objective is, however, but another phase of management's attempt to control costs. (For a detailed discussion of distribution costs, see the Accountants' Handbook, Wixon, ed.)

A summary of some of the objectives pertinent to both manufacturing and distribution costing is given in NAA Research Series No. 19 (NAA Bulletin, vol. 32):

In the operation of a business it is necessary to decide what products to sell, where and to whom to sell them, how to price them, and what methods to use in selling.

In making such decisions, management needs to have cost and income data for individual product lines, territories, customers, and other units which are dealt with. Since these decisions are made in the planning stage of management at which alternative courses of action are compared and choices are made, both historical and prospective future costs are needed. When reliable measures of the relative profitability of individual units in the over-all picture are lacking, management may hesitate to act or it may act blindly.

Determination of costs and profit margins by products, territories, and other lines of activity requires assignment of costs to those lines of activity. Both manufacturing and nonmanufacturing costs must be assigned in order to provide complete coverage of factors which affect profitability of individual units.

ADMINISTRATIVE COSTS. When administration is accepted as a separate function of business enterprise, administrative costs may be defined as those which have to do with phases of operations not identifiable with the production, sale, or financing of operations. They are costs incurred in connection with **policy formation** and the over-all direction of a business. Salaries of major executives, general services such as accounting, mailing, and personnel, as well as a miscellany of expenditures for donations, directors' fees, and expenses of annual stockholders' meetings are included in this category.

Separate Administrative Classification. Over the years there has been a continuing argument questioning the validity of a separate function called "administration" existing on a level parallel with the manufacturing and distribution functions. Those opposed to a separate administrative classification argue that executives do not administer to administer, but they administer to obtain the production or sale of goods or services. They argue that administration is a part of the production and distribution functions of management and that where treated as a cost of these functions, more accurate and complete cost information becomes possible. Those who favor a separate administrative cost category argue that nothing would be gained by arbitrary allocations of administrative cost and that control over administrative cost is best achieved by maintaining the administrative category.

It seems that the treatment of administrative cost is a matter of objectives and the extent to which certain refinements of accounting can be achieved. The pragmatic test of usefulness should be applied to this question. If greater efficiency in the management of a particular business or a better interpretation of its operations is obtained by following a certain method of handling administrative costs, administrative costs should be classified accordingly.

Arguments For and Against Division. A summary of the pros and cons of this argument is given by a special committee of the National Association of Cost Accountants (NAA Bulletin, vol. 15):

Should Administrative Expenses Be Divided Between Manufacturing and Selling?

Affirmative

I. In a manufacturing business there are no activities which do not serve the principal functions of production and selling.

   A. It is true that general office salaries, expenses incurred in connection with the maintenance of corporate records, legal expenses and other general expenses are not incurred solely for production or solely for selling.

   B. Nevertheless such expenses are brought about by the activity of the organization as a producing and selling unit.

II. In order to obtain the total manufacturing cost and the total selling cost of the product, it is essential that administrative expenses be allocated to production and selling.

A. It is as feasible to make such an allocation as it is to prorate various manufacturing costs between departments, or various selling expenses between offices.

B. Proper inventory valuation requires that administrative costs assignable to manufacturing be included in the unit costs of the product.

C. With prohibition of sales below cost, the importance of having the true total cost (compounded from all proper manufacturing and selling elements) should be recognized.

III. Where administrative expense is distributed to production and to selling, and budgetary control is in operation, there is a better incentive, and a wider opportunity, to exercise control over such expenses.

A. When administrative expenses are simply handled as a deduction from the profit on sales, there is a tendency to overlook the possibilities of strict control.

B. Control cannot be had without knowledge, and information as to the exact effect of administrative expenses on production and on selling is what is needed to point the way to needed efficiencies and economies.

Negative

I. To attempt to divide administrative expenses between production and selling is to distort the functional relationships of the enterprise.

A. To follow the line of reasoning of the affirmative, it might be said with equal logic that the primary purpose of an enterprise is to sell its product, and that, therefore, in the final analysis every cost is a selling cost.

B. As a matter of fact, the primary functions of management are three—financing, manufacturing, and selling.

1. So-called administrative expenses are at least partly concerned with the financial function.
2. There is no more justification for charging all such expenses against production and selling than there would be to charge them all against the financial function.

II. An effort to prorate administrative expenses between manufacturing and selling would not produce true costs as between departments, lines of product, etc.

A. In the absence of really reliable measures of performance (especially where financial function costs are being distributed where they do not belong), it is necessary to use arbitrary methods of distribution, for the relationships of administration to manufacturing and selling are far more indirect than are the relationships within the manufacturing section or the selling section.

B. The inclusion of administrative costs in the inventory value runs counter to established principles of inventory valuation.

III. It is true that too little attention is paid at times to control over administrative expenses, but it does not follow that such expenses must be buried in manufacturing and selling costs in order to have proper control exercised.

A. In fact, neither the production executives nor the selling executives are in a position to control administrative expenses.

B. It is the duty of management to control such expenses, and this can be better accomplished by having complete information about the relationships of all costs than by combining unrelated costs.

On the problem of allocating the administrative costs between production and distribution, Brummet (Overhead Costing: The Costing of Manufactured Products) states:

> If there were no practical limits on the cost of record keeping, most if not all of these [administrative] costs could be reasonably associated with either production or selling. Because of such practical limits they have been allowed to create a separate pigeonhole for themselves for accounting purposes. This has perhaps facilitated cost control by providing separate responsibility centers for budgeting and viewing efficiencies, but since there has been little effort to determine the timing of benefits to be derived from costs placed in such a pigeonhole, it has served to deter refinements of product costing and income determination

FINANCE COSTS. Another questionable function separate from that of production and distribution is finance. Boyd and Dickey (Basic Accounting) define the finance function as "the process of supplying the money or credit necessary to conduct the operations of production and distribution." Under this definition, finance costs become, therefore, a type of overhead to other functions of business enterprise much in the same manner as some accountants would interpret administrative cost. Accountants, however, do not generally agree to the showing of financial cost either as a cost of manufactured product or as a cost of distribution. In general, it is only where financial costs are incurred at the time of organization or in the construction of fixed assets for a company's own use that it is advocated that they be capitalized rather than shown as a nonoperating expense.

Paton (Advanced Accounting) argues that **interest paid on long-term debt** should neither be included as a cost of capital nor shown as an expense in a separate section of the income statement:

> Are interest charges accruing on borrowed capital expenses or assignments of net income? The answer evidently depends upon the fundamental point of view adopted. Looked at through the eyes of the proprietary equity, interest appears as a deduction congruous with labor, materials, and other costs of operation; from this position interest represents a payment for a definite service—the use of the capital contributed by bondholders and other contractual investors. From the managerial standpoint, on the other hand, the operating costs of the business entity are not affected by the form of capitalization—the particular devices employed to secure the necessary funds. To the manager the bondholders' dollars, like those furnished by stockholders, become amalgamated in the body of resources subject to his administration, and the net income of the enterprise consists of the entire amount available for assignment to all classes of investors. According to this position, interest charges should be excluded from expenses and should be grouped with dividends as income distributions.

The AAA Committee on Accounting Concepts and Standards (Accounting and Reporting Standards for Corporate Financial Statements) takes the position that, "Interest charges, income taxes, and true profit-sharing distributions are not determinants of enterprise net income." They are distributions of it. Some of these same items will be deducted, however, to compute "net income to shareholders."

Bases for Analyzing Costs

IDENTIFICATION AND MEASUREMENT OF COSTS. The Research Committee of the National Association of Accountants (Research Series No. 34, Classification and Coding Techniques to Facilitate Accounting Operations), on the basis of the experience of the companies it studied, emphasizes the

necessity for thorough work on classification before proceeding to the coding stage. It recommends observance of the following generally accepted **rules for classification:**

1. Items should be classified by one characteristic at a time.
2. Overlapping classifications should be avoided. That is, each item should fit into only one classification.
3. A place should be provided for every item in a group to be classified. A miscellaneous classification may be used for a small number of items not important enough in total to justify separate groups.

Some of the more common bases of cost identification and measurement are by:

1. Nature of expense.
2. Time period.
3. Function.
4. Area of responsibility.
5. Costing unit.
6. Relationship to object costed, direct or indirect.
7. Behavior, fixed or variable.
8. Time when computed.

Costs classified by **nature of expense** are gathered together in such natural groupings as rent, utilities, depreciation, salesmen's commissions, and donations. In turn, modern accounting makes a careful analysis of such expenses to determine their applicability to past, present, or future **time periods.** With the development of cost accounting, it was found that a more useful analysis of cost could be obtained by classifying costs according to business **functions or activities.** Total costs are classified into such major functions as: production, distribution, and finance. Production costs in turn may be subdivided into producing and service departments. **Production departments** are those manufacturing departments which work directly in connection with products manufactured. **Service departments** are those departments which expedite the work of the production departments. Costs of the distribution function may be subdivided into storing, packaging, transporting, direct selling, advertising, and order filling

Classification by functions does not necessarily imply classification by **areas of responsibility.** Both producing and service departments may have one central supervising authority over individuals who in turn supervise one or more departments. The major reason for a departmental distinction may be to distinguish one technical productive process from another. An area supervisor may have charge of several departments where lines of authority lead from the area supervisor to a cost center supervisor. Henrici (Standard Costs for Manufacturing) defines a **cost center** as "a unit of endeavor under the lowest level of supervision, buying materials and services from other centers, incurring expenses within itself, and in turn perhaps selling materials and services to other centers." **Operations** are activity subdivisions of cost centers.

COSTING UNITS. The costing unit is a major device for separating costs into those which apply to inventories from those which belong to cost of goods sold, for comparison purposes, and for other managerial uses. Ordinarily the unit is expressive of the **weight, dimensions, or container** used to house the object under consideration, such as tonnage weight of castings in a foundry, board feet in a lumber mill, and cases in a cannery. As contrasted to other bases used for analyzing costs, the costing unit is representative in part or in whole of what management is striving for in productive processes. The costing unit is often also a convenient way of expressing a sales transaction.

Typical Industry Cost Units. A comprehensive illustration of units utilized by various industries follows. It must be recognized, of course, that technological or other changes may occur in the industry at any time and that these may require a change in the cost unit.

Cost Units for Representative Industries

Product or Operation	Industry	Basis
Acid phosphate	Fertilizer.	Pound or ton.
Adding machines	Office appliance.	1 unit (special). 100 units.
Alloy, melted	Brass foundry.	Pound.
Apricots	Dried fruit.	30-lb. cases—(sales weight).
Automobiles	Automobile.	1 or 100 units.
Automotive parts	Automotive parts.	100 units.
Barrels	Cooperage.	100 units.
Batch materials	Glass container.	Cwt. finished ware.
Battery parts	Battery manufacturing.	100 units.
Batteries, wet	Battery manufacturing	100 units.
Beet sugar	Sugar.	100 lb. (1 bag).
Bolts	Screw machine	100 pieces.
Bookkeeping machines	Office appliance.	1 unit (special). 100 units.
Bricks	Face brick.	1,000 units.
Burned ware	Clay products.	Units completed.
Calculating machines	Office appliance.	100 units.
Car wheels	Chilled car wheel.	100 lb.
Castings	Various foundries.	Pound or unit
Cement	Cement.	Ton (raw mill). Barrel (clinker burning). Paper or cloth sacks (sales unit).
Chemicals	Chemical.	Gallon.
Cleaning	Stove.	Pound.
Cold creams	Pharmaceutical.	Jar or tube.
Core-making	Gray iron foundry.	Job (special). Unit (standard).
Core-making	Stove.	100 pieces.
Cosmetics	Pharmaceutical.	Gram.
Cough drops	Pharmaceutical.	Gram.
Cutters	Printing.	Units and sheets.
Flour	Milling.	Gram and bushel. 98-lb. sacks. 196-lb. barrels.
Folding	Printing.	Units and sheets.
Forged brass parts	Pressed metal stamping.	100 pieces.
Forged steel parts	Pressed metal stamping.	100 pieces.
Freight car loading	Various.	Pound or unit. Package or car.
Furniture	Furniture.	Each article.
Grapes	Dried fruit.	100-lb. boxes. 100-lb. bags.
Hollow tile	Clay products.	Ton.
Kegs	Cooperage.	1,000 bd.-ft.

Cost Units for Representative Industries (cont'd.)

Product or Operation	Industry	Basis
Lumber	Woodworking.	1,000 bd.-ft.
Machine parts	Screw machines.	100 pieces.
Melting	Gold plating.	Ounce.
Melting	Gray iron foundry.	Pound.
Melting	Stove.	Pound.
Mine clay	Clay products.	Ton. Pound (bulk).
Molding	Stove.	100 pieces.
Mouth washes	Pharmaceutical.	Gallon.
Nickel plating	Various.	Unit based on surface area.
Nuts	Various.	Pieces.
Painting advertising signs.	Advertising.	Job order.
Patterns	Stove.	Single unit.
Pills	Pharmaceutical.	Per 1,000.
Piston rings	Automotive.	1,000 pieces.
Presses	Printing.	Units and impressions.
Pressing	Gold plating.	Shell.
Processed fabric	Rubber tire.	100 sq. yd.
Prunes	Dried fruit.	Pound (sales weight).
Raisins	Dried fruit.	25-lb. cases.
Rubber	Rubber tire.	Pound or area (crude state).
Ruling	Printing.	Units and sheets.
Salt	Salt mining and refining.	Ton and 280-lb. barrels. 25 to 70-lb. sacks. 71 to 200-lb. sacks. 1 to 10-lb. packets.
Screws	Screw machine.	100 pieces.
Sheet brass parts	Pressed metal stamping.	100 pieces.
Sheet steel parts	Pressed metal stamping.	100 pieces.
Sheetings	Cotton textile.	Pound or yard.
Slug casting machines	Printing.	Em—unit of 6 min.
Springs	Various.	100 pieces.
Stampings	Stove.	100 pieces.
Stampings	Automotive parts.	100 units.
Stampings	Gold plating.	Ingot.
Sugar beets	Sugar.	Ton.
Sulphuric acid	Fertilizer.	Pound and ton.
Swaging	Gold plating.	Ingot.
Tablets	Pharmaceutical.	Per 1,000.
Tappets	Automotive.	1,000 pieces.
Tinning	Various.	Weight basis.
Tires	Rubber tire.	Per tire.
Tire casings	Rubber.	100 casings.
Tooth paste	Pharmaceutical.	Pound (bulk). Tube (unit).
Vacuum cleaners	Vacuum cleaner.	100 pieces.
Valves	Various.	1,000 pieces.
Wood parts	Various.	Production in rough mill. Production in finished mill.
Yarns	Cotton textile.	Pound and yard.

DIRECT AND INDIRECT COSTS. In the early development of cost accounting, the terms "direct" and "indirect" costs had a straightforward and easily understood meaning. Where significant cost items were obviously related in a physical manner to a unit of output, they were deemed to be direct; where not, they were considered indirect. A somewhat expanded concept of the terms was given by the Committee on Cost Concepts and Standards of the American Accounting Association (Accounting Review, vol. 27): "Direct costs are those costs obviously traceable to a unit of output or a segment of business operations."

The latter phrase of the definition amplifies the meaning of direct costs to apply to varying objects of managerial interest. For example, if management is interested in the control of a department's operations, direct costs will represent those costs obviously traceable to that department's operations. If, on the other hand, management is concerned with the problem of replacing hand labor on a particular operation with machinery, costs traceable to the operation are direct.

It should be noted at this point that modern usage of the words "obviously traceable" or "related" do not refer necessarily to a physical relationship between the cost item and the object undergoing costing. For **product costing** purposes, for example, the relationship sought is one between the behavior of a cost and changes in output. Whether a change in cost accompanies changes in output may be indicated by a **scatter diagram** or **least-squares analysis.** In such an instance, the terms "direct" and "indirect" become roughly equivalent to **variable** and **fixed.**

Direct Costing and Cost of Classification. In recent years the term "direct costing" has come into vogue to further confuse the semantics of direct and indirect costs. Direct costing refers to a philosophy and methodology of costing which in varying degrees would exclude fixed costs from inventories. Ideally, in direct costing, only **variable costs** of manufacture would be included in inventories and cost of goods sold. (For a discussion of direct costing see section on Manufacturing Overhead and Product Cost.)

FIXED AND VARIABLE COSTS. Direct costing technique makes apparent the expediency resorted to in the definitions of direct and indirect costs given in the preceding discussion. Logically the problem of causally relating costs to product belongs within the sphere of fixed and variable costing. Henrici (Standard Costs for Manufacturing) makes a basic differentiation between those costs which may be related to the **productive standard hour** of the operation (variable costs) as contrasted to those entering into the computation of the **normal overhead rate** of the cost center (fixed costs).

Variable costs are those costs which fluctuate with changes in output. Fixed costs are those costs which tend to remain relatively constant, despite changes in output. (See section on Accumulation of Manufacturing Overhead for a detailed discussion of fixed and variable costs.)

RELATIONSHIP OF COSTING UNIT TO PRODUCT COSTS. In manufacturing cost accounting, costs classified by nature of expense are ultimately related to units of product. In **job costing,** for example, costs determined to be direct are related to job orders, material costs via requisitions, and labor costs via time tickets. Other costs are allocated to jobs by means of overhead rates. Once the total cost of a job is ascertained, it is divided by the number of units encompassed by the job, and an average cost per unit is derived. In this and other instances the costing unit and the finished product may not be the same. Where a job order has as its objective the manufacture of a component part, the part may become the costing unit of the particular job. Later the cost of the

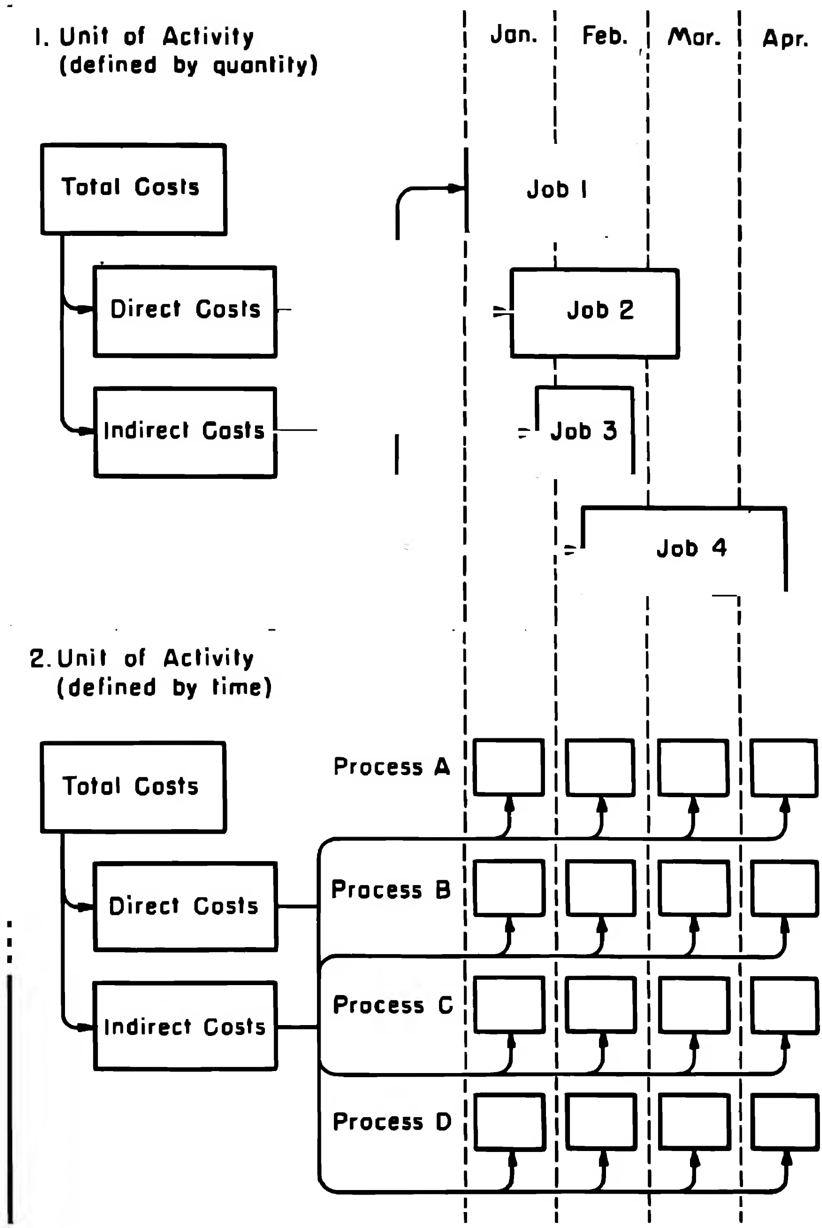


Fig. 3. Apportionment of costs and expenses to units of activity.

part may be combined with the cost of other pieces and parts to obtain the cost of finished units of product.

In a **process cost** accounting system, costs incurred during a specified period of time are traced to process classifications. In turn the cost of each process is divided by the equivalent units produced by the process during the time period specified. Average unit costs of each area are summarized to obtain total unit costs of products produced. A process cost report is utilized to expedite these computations.

Fig. 3, adapted from Fitzgerald and Schuman (Classification in Accounting), portrays costing units in job and process cost accounting as activity units. Those used in job costing are defined by a specified quantity independent of the time period, and those used in process costing are defined by activity with respect to a specified time period.

CLASSIFICATION BY TIME WHEN COMPUTED. Where costs are computed following the incurrence of cost, they are referred to as **historical costs.** The direct costs of job costing are historical costs. When overhead costs are prorated at the conclusion of a period, they are termed historical costs. When overhead costs are computed in advance of use in a job or process cost system, they are referred to as **estimated** overhead costs. In a standard cost system, costs computed in advance of use are referred to as **predetermined** or **precomputed** costs.

Uses of Symbols and Codes

DEFINITION OF CODING. NAA Research Series No. 34 (Classification and Coding Techniques to Facilitate Accounting Operations) states that coding follows classification and defines coding as "the assignment of numbers, letters, or other symbols according to a systematic plan for distinguishing the classifications to which each item belongs and for distinguishing items within a given classification from each other."

NEED FOR SYMBOLS. Symbols and codes are substitutes for the use of lengthy account titles and are applied to a given classification of accounts. Because of their use, considerable time and effort can be saved in the sorting of account information. With the development of machine-sorting processes, coding systems have assumed increasing importance in industry.

The use of codes and symbols is discussed here primarily in relation to their use on accounts. The principles discussed may be applied to other classifications; as for example, sales statistics by territory, product line, customer, or salesman, or other material and product classifications.

Heckert and Kerrigan (Accounting Systems) state the general purposes of a system of coding to be the following:

1. Locates accounts quickly.
2. Reduces time for writing identity of accounts.
3. Aids in classifying transactions.
4. Is easy to remember or identify.
5. Facilitates mechanical sorting (e.g., punched cards).
6. Allows for adding or dropping accounts.

RESPONSIBILITY FOR CODE DEVELOPMENT. NAA Research Series No. 34 (Classification and Coding Techniques to Facilitate Accounting Operations) states:

In the past, codes were usually developed within the functional area which originated and made primary use of the data coded. For example, materials codes were

designed by the manufacturing department and account codes by the accounting department. Recent trends in data processing methods have emphasized the interrelationships between codes. As a consequence, increasing integration of data processing operations has required integration of codes used in such operations. Code revision is accordingly an effort in which all of the interested functional responsibilities must cooperate.

This NAA research report, after noting that specialists in individual areas such as **accounting, sales,** and **production** are needed in classification work, observes:

Most major classes of coded business data affect the accounts at some point, and the chief accounting executive is frequently responsible for data processing operations. For this reason, leadership in code revision and development is often assigned to the accountant who serves as a coordinator.

TESTS OF SATISFACTORY CODE. Gillespie (Accounting Systems) raises a number of questions to be asked concerning a code under consideration:

1. Does it aid the memory of the user? (A code should be easy to apply and to decipher.)
2. Is it concise? How many digits or letters will be required to identify a name in the list? Long, cumbersome code numbers are to be avoided because in general they defeat their purpose. Also when code numbers are to be handled by accounting machinery, code digit space is likely to be at a premium.
3. Does the code system provide for expansion when new items come to light in such a manner as to keep the whole list in order? Does it provide for (a) addition to new main classes and (b) subdivision of existing classes?
4. Does the code positively identify each item with the group to which it belongs? Thus some codes applied to balance sheet accounts are designed to show whether an account is asset, liability, or net worth, and futher (if an asset), whether current or fixed, and so forth.
5. Will the coding operation be expensive to perform?

NAA Research Series No. 34 (Classification and Coding Techniques to Facilitate Accounting Operations) states, "The code chosen should have sufficient scope and flexibility to handle the number of classifications and items to be coded, but should at the same time be as simple as possible." It points out that the data-processing operations to be performed with coded information are a very important factor in choosing a code. This report also states that codes must be acceptable to the people who use them and that they will operate more effectively if they are designed with the limitations of the personnel in mind.

TYPES OF CODES. Types of codes in business use may be subdivided into (1) numerical, (2) decimal, and (3) letter and mnemonic codes.

NUMERICAL CODING SYSTEMS. Numerical codes may in turn be classified into sequence codes, block codes, and group codes.

Sequence Codes. These codes are utilized by assigning numbers in numerical order to items under classification. This system is sometimes referred to as **straight numbering.** In coding accounts receivable, for example, the first customer's name of an original alphabetical list would receive a number beginning with 1, the second 2, and so on until all customers' accounts were numbered. Difficulties with the sequence code become apparent as new accounts are obtained and must be numbered entirely out of alphabetic order. Sequence codes, however, are useful for the numbering of invoices, requisitions, lot tags, job orders, and other business papers where coding convenience is achieved by numbering in order of time occurrence.

Gillespie (Accounting Systems) comments on sequence codes:

> Sequence codes are often practical for short lists. It should be noted that the lack of order is a hindrance to memorizing, but this factor may not be important. (Payroll clerks quickly memorize several hundred numbers and more or less instinctively locate employees on the records by number.) Sequence codes do not define groups within the list.

Block Codes. A block code remedies the basic deficiency of a sequence code. It permits numeric coding of a predetermined classification but allows for expansion in the number of items within each classification. For example, the number 100 may be used for current assets, 200 for investment assets, 300 for fixed assets, and so forth. In turn, important current assets may be numbered within the basic block: 100 for cash, 110 for accounts receivable, and 120 for inventories. Leeway for expansion is allowed within each block by saving numbers for additional subclassifications.

Block Code Application. Heckert and Kerrigan (Accounting Systems) give the **chart of accounts** of a company manufacturing a complete line of bolts, nuts, screws, and rivets for the hardware and construction trade, which illustrates the actual application of a block-numbering system. Account numbers for assets are coded 1–99; liabilities, 100–199; income and charges, 200–299; and expenses, 300–999. Space is left for expansion in the subclassifications as in the coding for manufacturing overhead expense accounts on the next page.

Group Codes. Group codes are similar to block codes except that they allow for almost unlimited subdivision of classifications by means of positioning digits. The first digit in a code number represents the **major classification**; the second digit, the **secondary classification**; and subsequent numbers, finer subdivisions. Thus, a code such as:

1000 Assets
1100 Current Assets
1110 Cash
1111 Petty Cash

requires four digits: the first digit representing assets; the second, the class of asset (current, investment, or fixed); the third digit, the types of asset within the class like cash in the foregoing; and the fourth a subdivision of a type like cash into bank, payroll cash, petty cash, and other cash accounts. If other parts of the code require further subdivision, it is desirable to add another digit to preceding numbers in order that all code numbers may have the same number of digits and so that the position of each digit from either left or right has the same significance.

Kean (NAA Bulletin, vol. 37) illustrates a coding system which, for the most part, can be described as a group system. Each major classification of accounts is given a block of numbers; for example:

100–199 Assets
200–299 Liabilities and Capital
500–2000 Profit and Loss accounts

Each group is in turn subdivided; for example, the numbers in the Assets account group are broken down as follows:

100–139 Current Assets
140–159 Fixed Assets
160–179 Deferred Charges
180–199 Other Assets

Manufacturing Overhead Expenses

400 Manufacturing Overhead Expense Control

Detail

401 Supervision—Foremen and Assistants
402 Overtime Bonus
403 Suggestion Awards
404 Christmas Bonus
405 Vacation Wages
406 Provision for Wage Increase
407 Holiday Pay
408 Lost Time
409 Packing Shipping Containers—Labor and Material
410 Auxiliary Department Processing—Labor and Material
411
412 Other Departmental Labor
413 Inspection and Assorting
414 Clerks, Checkers, and Weighers
415
416
417 Inside Trucking and Material Handlers
418
419
420
421 Personnel Department Expense
422 Tabulating Department Expense
423 Cost Department Expense
424 Payroll Department Expense
425 Purchasing Department Expense
426 Production Control Expense
427 Factory Manager and Superintendents
428 Clinic Expense
429 Research, Metallurgical, and Product Design Engineering
430 Engineering—Mechanical
431 Finished Wire Storage
432
433 Finished Goods Storage
434 Receiving, Storerooms, and Inbound Transportation
435 Building Service
436 Plant Protection—Watchmen
437 Waste Treatment Plant
438 Heating and Air Conditioning
439 Cafeteria and Kitchen
440 Maintenance of Land Improvements
441 Outside Trucking
442 Building Repair and Maintenance
443 Machinery Repair and Maintenance
444 Electrical Repair and Maintenance
445
446
447
448
449 Experimental—Miscellaneous
450 Experimental—Screw Stick
451
452
453 Scrap Salvaging
454 Tools and Machine Parts—Labor and Materials Purchased
455 General Supplies
456
457 Gas
458
459 Purchased Power and Light
460 Machinery Rentals
461 Perishable and Permanent Tools
462 Tools and Machine Parts Processing Expense Unabsorbed
463 Mill Box Expense
464 Traveling Expense
465 Plant Rearrangement
466 Inventory Expense
467
468 Paper Boxes Processing Expense Unabsorbed
469 Shipping Cases Processing Expense Unabsorbed
470 Wire Drawing Processing Expense Unabsorbed
471 Workmen's Compensation Insurance
472 Group Insurance
473 Hospitalization Insurance
474 Payroll Taxes—F.O.A.B.
475 Payroll Taxes—S.U.I.C.
476
477
478
479
480
481 Pensions
482 Depr.—Land Improvements
483 Depr.—Buildings
484 Depr.—Building Equipment
485 Depr.—Machinery and Equipment
486 Depr.—Furniture and Fixtures—Shop
487 Depr.—Autos and Trucks
488 Depr.—Cafeteria Equipment
489 Office Equipment
490 Local, County, and State Taxes
... .
499 Miscellaneous Mfg. Expense

Group Code Application. Detail of a portion of the accounts where a major block code classification [from Kean (NAA Bulletin, vol. 37)] is converted into a group coding system is shown in the accompanying chart.

DETAIL CHART OF ACCOUNTS (Portion)

Assets

Account Nos	Current Assets	Old Account Nos.
100	Cash in Banks—Regular Accounts	102
-1, etc.		
101	Cash in Banks—Payroll Accounts	103
-1, etc.		
102	Cash in Banks—Special Accounts	102
-1, etc.		
103	Cash in Banks—Dividends	102
-1	Common	
-2	Preferred	
104	Bank Transfers (own plants)	129
105	Cash on Hand (Imprest Petty Cash Fund)	101
-1	Petty Cash	
-2	Petty Cash Exchange	
106	Marketable Securities (detail in subsidiary ledger)	110-2
-1	U.S. Government Securities	
-2	State and Municipal	
-3	Corporate Securities (other than associated companies)	
	A Stocks	
	B Bonds	
107-etc.		

DECIMAL CODING SYSTEMS. The decimal coding system is an extension of group coding. In decimal systems almost unlimited subdivision of a major classification may be obtained by using digits to the right of the decimal point.

Decimal Code Application. The MAPI Accounting Manual presents a coding system for **capital goods industries** premised on the decimal system. Major classifications are assigned numbers from 1 to 9 as follows:

1. Assets
2. Liabilities and Capital
3. Sales Revenues
4. Manufacturing Cost of Sales
5. Sales Engineering Expenses
6. Administrative Expenses
7. Other Expenses
8. Redistributable Factory Expenses
9. Redistributable Engineering Costs

Each major classification is subdivided as, for example, assets:

11. Current Assets
12. Notes and Accounts Receivable (due beyond one year)
13. Securities of and Noncurrent Advances to Controlled Subsidiary Companies
14. Investments
15. Property, Plant, and Equipment
16. Accumulated Wear and Obsolescence (credit)
17. Patents, Trade Marks, and other intangibles
18. Prepaid Expenses and Deferred Charges
19. Equalization Accounts

In turn, each of the foregoing is subdivided as, for example, current assets:

11.1 Cash
11.2 Marketable Securities
11.3 Accounts and Notes Receivable
11.4 Due from Employees
11.5 Due from Subsidiary Companies
11.6 Inventories
11.7 Advance Payments to Vendors
11.8 Unassigned
11.9 Customer Advances on Contracts (credit)

The expansion potentialities of the decimal code is indicated in Fig. 4, the MAPI application to the detailed **subsidiary expense accounts** of three engineering departments. Fig. 4 is a typical list of the subsidiary expense accounts that

Expense Account Number	Name of Expense Account	Redistributable Engineering Departments: Design Engineering 91	Drafting 92	Research 93
.01	Compensation—Productive	91.01	92.01	93.01
.03	Compensation—Non-supervisory	91.03	92.03	93.03
.04	Compensation --Supervisory	91.04	92.04	93.04
.08	Instruction and Training	91.08	92.08	—
.09	Overtime Bonus	91.09	92.09	93.09
.12	Pensions	91.12	92.12	93.12
.13	Social Security Taxes	91.13	92.13	93.13
.14	Social Insurance Benefits	91.14	92.14	93.14
.20	Supplies	91.20	92.20	93.20
.21	Expendable Tools	91.21	92.21	93.21
.30	Repairs and Maintenance Furniture and Equipment	91.30	92.30	93.30
.31	Repairs and Maintenance Bldgs., Roads, and Grounds	91.31	92.31	93.31
.33	Rearrangement of Facilities	91.33	92.33	93.33
.40	Errors	91.40	92.40	—
.47	Power, Light, and Heat	91.47	92.47	93.47
.52	Accident Compensation	91.52	92.52	93.52
.61	Telephone and Telegraph	91.61	92.61	93.61
.62	Traveling	91.62	92.62	93.62
.65	Association Dues and Expenses	91.65	92.65	93.65
.67	Patent Expense	91.67	—	93.67
.70	Consultant Services	91.70	—	93.70
.80	Miscellaneous	91.80	92.80	93.80
.87	Wear and Obsolescence	91.87	92.87	93.87
.92	Productive Salaries Distributed (Credit)	91.92	92.92	93.92
.93	Expense Absorbed at Standard Rates (Credit)	91.93	92.93	93.93

Fig. 4. Typical chart of redistributable engineering expense accounts, decimal coded.

will be needed by the manufacturer of machinery for redistributable engineering departments. Some companies will consider it unnecessary to divide the expenses to the extent indicated, while others will consider it advisable to provide additional accounts and additional departments. The assumptions made as to authority and responsibility in establishing the departmental accounts will not necessarily be applicable to all companies. Each company should establish the departmental accounts in accordance with its lines of authority and responsibility.

LETTER AND MNEMONIC CODING SYSTEMS. Coding of a chart of accounts or other business data may be accomplished by means of letter codes or a combination of letters and numbers. Letter code designations may be assigned alphabetically to a chart of accounts; for example, A for Current Assets, B for Investment Assets, and C for Fixed Assets. In turn, individual assets within the major classification may be coded: Cash, Aa or A1; Accounts Receivable, Ab or A2.

Neuner and Neuner (Accounting Systems) present a chart illustrating the coding of accounts by numerical coding and alternatively by letter coding, as shown in the listing here.

Accounts	Numerical Code	Literal Code
Current Assets		
Cash	11	ACA
Petty Cash	12	ACB
Accounts Receivable	13	ACC
Notes Receivable	14	ACD
Reserve for Doubtful Accounts	15	ACE
Inventories	16	ACF
Interest Accrued on Notes Receivable	17	ACG
Fixed Assets		
Machinery and Equipment	31	AFA
Reserve for Depreciation on Machinery and Equipment	32	AFB
Furniture and Fixtures	33	AFC
Reserve for Depreciation on Furniture and Fixtures	34	AFD
Goodwill	35	AFE
Current Liabilities		
Accounts Payable	41	LCA
Accrued F.I.C.A. Tax	42	LCB
Withholding Tax Payable	43	LCC
Fixed Liabilities		
Bonds Payable	51	LFA
Net Worth		
Capital Stock	60	CA
Surplus	61	CB
Selling Expenses	70	SEA
Administrative Expenses	80	AEA
Other Expenses	90	OEA
Other Income	100	OIA

NAA Research Series No. 34 (Classification and Coding Techniques to Facilitate Accounting Operations) observes: "Symbols should, whenever possible, be significant in the sense that they state, or assist the user to recall, characteristics of the items for which the symbols stand."

Usually **mnemonic codes** use letters which call to mind certain features of the items and by association help to identify them. Gillespie (Accounting Systems) adds:

> Mnemonic codes, like other codes, are often applied to show the relationship between each item and the group to which it belongs. Thus: FBA means front bolster assembly, and FBAA means front axle (which is a part of the front bolster assembly)

NAA Research Series No. 34 cites two principal advantages that have been advanced for the use of **alphabetical symbols:**

1. More classifications can be denoted with a single position. That is, if all letters are used, twenty-six alphabetical symbols are available, while there are only ten numerals.
2. Alphabetical symbols can be designed to suggest names of the items identified The three-letter code used by airlines to designate cities is a familiar example

Effect of Data Processing Improvements on Coding. NAA Research Series No. 34 emphasizes the interrelationships between changes in data processing equipment and coding applications: "Revision of codes is often undertaken in preparation for introduction of high-speed data processing equipment because, to use such machines, both the data to be processed and the instructions which control machine operations must be coded." This NAA research report discusses these interrelationships along the following lines:

1. Classifying by frequency of use to reduce data handling time.
2. Coding to facilitate access and to improve utilization of memory capacity.
3. Devising unique checkable identification symbols where large numbers of similar items come within a classification plan.
4. Using integrated and coordinated codes in integrated data processing.

CHART OF ACCOUNTS. Kean (NAA Bulletin, vol. 37) defines a chart of accounts as:

> . . . a uniform, systematic listing of assets, liabilities, capital, income, and expenses in a logical order, giving account names and numbers so that accurate financial statements may be extracted and prepared in the sequence that they will be shown on the balance sheet and statement of profit and loss.

Criteria for Useful Chart of Accounts. Heckert and Kerrigan (Accounting Systems) describe a chart of accounts as "a working tool in the hands of the people who use it" and state that its usefulness depends on the following:

> **Adequacy.** An adequate classification provides the right number of individual accounts. The best test of adequacy is whether a classification can directly furnish the information wanted for the statements and reports to be prepared from accounts. A well-designed classification or chart of accounts strikes a medium between one that is too finely drawn, with an excessive number of accounts having insignificant balances, and one that is so summary as to conceal in accounts definitely significant information.
>
> **Accuracy.** The accuracy of a chart of accounts is tested by the degree in which the accounts "tie in" with the data they are assigned to assemble. To illus-

trate, if it is company policy to permit sales returns but not sales allowances, it would be inaccurate to set up an account for "sales returns and allowances."

Clarity. Errors of classification are often traced to poorly worded account titles. An account title should suggest the purpose for which it is to be used, and thus, so far as practical, be self-explanatory. Selection of clear titles has been the subject of research by many trade associations in their effort to recommend uniform classifications of accounts to member companies.

Heckert and Kerrigan indicate also that the chart of accounts should follow the organization chart; that it should provide summarized data in the general ledger; that the accounts should be arranged in the ledger for convenience; and that the numbering system should be simple and flexible.

Method of Preparation. No one chart of accounts will fit the needs of any two businesses except accidentally. The construction of a chart of accounts is an individual matter, since it must be tailor-made to the problems of a particular concern. Charts and codings of accounts as suggested by trade associations are helpful, but these must be condensed or expanded, accounts deleted or added, as required by specific managerial needs. Kean (NAA Bulletin, vol. 37) suggests:

> In the preparation of a chart of accounts, the type of business and the manner in which the financial statements are to be prepared should be taken into consideration. The individual receiving the assignment of revising or setting up a chart of accounts should first acquaint himself with the type of information that management needs or wants in order to interpret properly the activities of the organization, for the chart of accounts will not always follow exactly the set-up of accounts which might be made according to a textbook. It may and does change to follow the information and the order and the manner in which management wants its financial statements presented. It is advisable, also, to visit the plants, if the organization is a multi-plant operation, and discuss the chart and manual of accounts with the people doing the detail work, talking to individuals responsible for interpreting what account or accounts are to be charged and or credited and to those who do the posting and the preparation of financial statements.

Cost Systems

DEFINITION OF ACCOUNTING SYSTEM. Neuner and Neuner (Accounting Systems) define an accounting system as "an organization of forms, records, and reports, closely coordinated to facilitate business management through determining certain basic and required information." An accounting system is therefore a classification medium establishing a basic organizational pattern of the accounting data of a firm. A **cost system** is but one aspect of the accounting system as a whole, designed specifically to provide information concerning costs and efficiency.

JOB VS. PROCESS SYSTEMS. Managerial problems differ from industry to industry and from concern to concern, and consequently cost systems must be fitted to the needs of a particular management. The different applications of job and process cost accounting systems highlight the need for differing classifications of cost depending upon managerial problems at hand.

Job Costing. Where management's interest in costing lies in ascertaining the cost of special orders produced according to customers' specifications or in the production of pieces and parts to be later assembled in a variety of ways, the **job cost system** is utilized. Job costing is therefore employed in those instances where a simple averaging of costs incurred during a period over comparable units

is not feasible. (See section on Job Order Cost Systems for a discussion of the details of this system.)

Process Costing. Process costing is utilized in those industries where large quantities of rather homogeneous units of product are produced via conditions of continuous production or assembly operations. Production may be characterized as **production for stock** rather than **production to order** of the individual customer. Managerial interest in the use of a process cost accounting system lies less in the compilation of product cost information and more in the realm of departmental and unit cost data to be used for control purposes.

The focal point of costing in process cost accounting is the cost report. This report assembles material, labor, and overhead costs by processes in total dollars and per unit for each element of cost. The **process cost report** is the basis for the transfer of costs from one process account to another and from the final process account to a finished goods account.

Process material costs may be classified, as are material costs under any system of costing. For example, subsidiary raw material and finished stores accounts may be utilized. Manufacturing overhead costs may be accumulated in any way deemed convenient and useful; they are, however, commonly accumulated along with material and labor costs in control accounts, one for each process. Supporting such **process control accounts** are subsidiary papers detailing expense and cost items.

In process cost accounting, the terms "direct" and "indirect" undergo a shift in meaning from their application to job costing. **Direct costs** are those obviously related to the operation of a process. They include costs of materials and labor used by a process, depreciation on a process's own equipment, and cost of small tools employed by a process. Costs of general plant supervision, unmetered power cost, and depreciation of buildings are included among the **indirect costs** of a process. (See section on Process Costs for a discussion of the details of this system.)

HISTORICAL VS. PREDETERMINED SYSTEMS. A historical cost system is one which accumulates actual costs after operations have taken place. A simple process cost accounting system similar to that employed by canneries tends to be entirely historical in nature. A job order cost system often utilizes historical costs of material and labor but employs predetermined rates to obtain manufacturing overhead costs.

Where the costs of a factory or marketing organization are computed in advance of use, the system using such costs may be described broadly as a **predetermined cost system.** In an **estimated cost system** predetermined costs are used chiefly to facilitate the process of costing. (See section on Estimated Costs for a detailed discussion of this system.) In a **standard cost system** predetermined costs are carefully computed and later contrasted with actual costs to aid in cost control.

In a well-developed standard cost system, costs are classified both by products produced and by areas of activity. Classification of costs by area is carried often into considerable detail by cost centers and operations. Costs are also carefully classified into variable and fixed costs. Variable costs are related to the smallest subdivision of activity; for example, the operation. Since fixed costs are classified primarily for product-costing purposes, they are commonly classified by larger activity or area classifications, by departments or cost centers. (For details on standard costs, see sections on Setting Standard Costs, Operation of Standard Costs, and Analysis and Control of Standard Cost Variances.)

TIED-IN COSTS. In the early period of the development of modern cost accounting, many cost systems operated independently of the general financial system of accounts. The cost system was utilized for a variety of purposes; however, its costs received little or no recognition in the regular books of account. A cost system operated independently of the financial accounts is termed a **statistical system.** In today's practice, where utilized, such a system is likely to be a standard cost accounting system. A statistical cost system has flexibility as its outstanding advantage. Data may be expressed in nondollar as well as dollar form, in percentages, decimals, and physical units. Past, present, future, and hypothetical costs may be intermingled as desired.

Taggart (Accounting Review, vol. 26) argues that in many cases the cost accountant would be better off using estimates, approximations, round numbers, and in the matter of making forecasts and other analyses, perhaps **replacement costs,** rather than the exact historical costs. Taggart believes the cost accountant would feel freer to use these other figures if the cost records were not tied in with the general accounts. Peloubet (Journal of Accountancy, vol. 91), in urging companies to set up methods to determine accurate unit costs, points out that it is not necessary to have "tied-in" cost systems which require agreement between cost figures and book figures.

"Accounting costs" or "tied-in" costs are from a cost system tied in with regular accounts, which operates as an integral part of the whole system of accounts. It is coordinated with the financial ledger by means of interlocking or **reciprocal accounts,** such as Factory Ledger and General Ledger accounts, or through the use of a **Work-in-Process control account** or accounts supported by detailed subsidiary cost accounts. Although some flexibility in the type of data utilized is provided for in subsidiary ledgers and papers, a tied-in system must keep accounts in dollar form and follow the same basic concepts employed in the keeping of financial accounts.

A tied-in system has the advantages of objectivity and internal check required by the formal system of accounts. Howell (Contemporary Accounting, Leland, ed.) points out that this system provides an almost automatic check "against omissions, duplications, and errors in apportioning the sum total of costs." The tied-in system often saves considerable clerical effort in that an orderly keeping of the general ledger and tied-in accounts makes mandatory the efficient and rather automatic procedures affecting cost accounts, such as a purchase or sales order procedure, a payroll system, or the method of accounting for manufacturing overhead.

OBJECTIONS TO CONVENTIONAL COST CLASSIFICATIONS. Goetz (Management Planning and Control) is one of a number of writers who are critical of customary procedures for accounting for direct material, direct labor, and overhead costs. He despairs of the disutility of traditional cost classifications to management: "Because it is misconceived, is misdirected, and attempts the impossible, traditional cost accounting is at once overelaborate, inadequate, and misleading." To serve management best, Goetz states that account data should be classified:

1. According to rival programs of action.
2. According to the pattern of individual authority existing in a particular organization.
3. By liquidity, by contracts, or in special ways dictated by governments or creditors.

To achieve utility, Goetz holds that the accountant must begin with a **basic classification** which can be grouped and regrouped readily as various needs arise. Two basic principles essential to securing such an end are:

1. Transactions should seldom be divided; in the initial record each business act should be recorded as a whole.
2. Transactions should be merged only when components of the resulting class of data are homogeneous along all dimensions of managerial problems, be they problems of planning, control, or social contracts.

In a variety of records subsidiary to the basic classification, Goetz would permit such grouping and reworking of data as was appropriate to the managerial problem at hand.

Uniform Accounting Systems

DEFINITION. The Chamber of Commerce of the United States (The Acceptance and Installation of Uniform Methods of Cost Accounting) defines uniform cost accounting as follows:

Uniform cost accounting comprises a set of principles and, in some cases, of accounting methods which when incorporated in the accounting systems of the individual members in an industry will result in the obtaining of cost figures by the individual members of the industry which will be on a comparable basis. Uniform cost accounting does not mean the preparation of average or standard cost figures for the industry nor the inclusion in costs of predetermined or fixed elements of cost.

Uniform accounting systems have evolved out of the combined efforts of regulatory bodies, company members of industry, trade associations, and such organizations as the Chamber of Commerce of the United States. Government commissions, both state and federal, have required the keeping of uniform systems of accounts in regulated industries, such as public utilities.

Neuner (Cost Accounting) points to the attempts of various groups such as the Steel Founders Society of America and the Tri-City System (printers) to formulate uniform systems in the period 1902–1908. A report by the Federal Trade Commission in 1916, which revealed the inadequacy of many companies' cost accounting practices, stimulated the interest of trade associations in cost accounting and in uniform cost accounting systems. The **cost plus contracts** and increased government regulations during World War I drew added attention to the need for greater uniformity in cost procedures. During the NRA period (National Industrial Recovery Act, 1933–1935), uniform accounting systems were often prescribed within the industry codes. Today uniform accounting systems are available to a wide range of industries.

ADVANTAGES OF UNIFORM ACCOUNTING SYSTEMS. The Chamber of Commerce of the United States (The Acceptance and Installation of Uniform Methods of Cost Accounting) gives the following advantages available from uniform accounting systems:

1. Provides the "one best way" known to the industry to figure costs, thereby eliminating expensive experimentation by the members of the industry individually and independently.
2. Results in a better informed competition within the industry.
3. Enables the industry to place significant cost data before regulatory bodies.

4. Inspires confidence in the public that selling prices are established by producers who have full knowledge of the costs of the articles offered for sale.
5. Tends to convince the manufacturer, who otherwise would fail to see the advantages of good cost accounting, of the desirability of adopting the methods which his competitors are successfully using.
6. Reveals lines of individual products which have been marketed on an unprofitable basis.
7. Provides all the valuable features of sound cost accounting generally, among which are the following:
   a. Shows the danger line below which goods cannot be sold at a profit, thus serving as an insurer of profits.
   b. Acts as a guide to the value, efficiency, and waste of workers, machines, methods, operations, and entire plants.
   c. Provides a reliable guide and basis for estimating the cost of prospective business.
   d. Furnishes current reports for comparing major cost items with standards which are predetermined, and thereby measures and increases operating efficiency.

Government cannot regulate industry fairly unless it has available data in comparable form. Industry members, on the other hand, cannot bring an end to blind and often destructive competition unless all members have a common understanding of costs. A uniform accounting system is designed to spell out for an individual company the elements of cost that are common to all companies within the industry and to indicate ways of analyzing and summarizing costs to arrive at comparable unit costs. Some **trade associations** compile unit costs, ratios of separate items of cost to sales, etc., from the reports submitted by individual companies. They publish these data, usually as composite figures, averages, or graphs, to aid their members to control costs and to avoid underpricing their goods or services.

DISADVANTAGES OF UNIFORM ACCOUNTING SYSTEMS. Devine (Cost Accounting) states that "the greatest disadvantage (from the standpoint of society) of uniform costing is that conspiracies to restrain trade and impede competition may result." He questions, however, whether the medium of the trade association will prove any more effective than other monopolistic devices used by large firms in the past. Disadvantages from the point of view of industry members are:

1. The uniform system suggested by the association may not be sufficiently flexible to meet the needs of all members, both large and small.
2. The cost of installing and maintaining a uniform system may be at variance with benefits derived by individual members. For the smaller member, particularly, the system may be too costly to operate.
3. Terminology adopted by the group may not be sufficiently understood by individual members, thus resulting in different costs summarized under common classification headings.
4. Costs envisaged by the system, particularly where there is an effort to have uniform pricing policies, often include costs not applicable to other problems such as income taxation and financial accounting reporting. Imputed costs and depreciation costs resulting from suggested industry rates are examples of these.
5. Industry members may fail to report company data in whole or in part, in the fear that the figures may be used by a competitor in some way to gain an unfair advantage. This weakens the usefulness of statistics purporting to be representative of the industry.

REQUISITES OF A UNIFORM ACCOUNTING SYSTEM. Wheldon (Cost Accounting and Costing Methods) states that apart from the over-all question of type of system to be used, such as job or process, the following details need to be determined:

1. The bases for the apportionment and allocation of overhead.
2. The departments, sections, or production centers to be used for analysis and comparison of costs.
3. What items shall be regarded as factory expense, as distinct from administrative expense.
4. How expenses of administration, distribution, and selling shall be related to rates.
5. How expenses in connection with the buying, storing, handling, and issuing of stores materials shall be treated.
6. What rates of depreciation shall be applied to plant and machines.
7. Whether interest on capital is to be included, and if so, how and on what basis.
8. What rent charge is to be made for buildings if freehold or leasehold.
9. How service departmental costs shall be determined.
10. The demarcation between direct and indirect wages.
11. In the case of time work and piecework, whether the time or wage basis, or both, shall be used for determining expense rates.
12. What organization can be set up to prepare comparative statistics for use of those adopting the uniform system. Privacy of individual data and confidence in the coordinating office are essential factors.

NATURE AND SCOPE OF UNIFORM COST PLANS. The term "uniform cost plan" covers a wide range of activities varying from minor association activities which bear directly or indirectly on cost matters to the completely developed programs with formal cost accounting systems, reports, analyses, etc. Some of the activities in this general field which may be carried on partially or completely are as follows:

1. Papers, speeches, or discussions of matters pertaining to costs in trade publications, or at conventions.
2. Publication of educational literature as to problems and objectives of cost finding.
3. Studies of particular costing problems in the industry to develop sound principles.
4. Activities of a counseling nature relative to establishment or operation of cost accounting systems, but no effort to design a uniform system.
5. Development of estimating formulas or short-cut methods of establishing bases for pricing.
6. Development and promotion of a uniform cost program.
   a. Principles of costing only, with no attempt to prescribe procedures or records.
   b. Definition and identification of cost factors to be recognized and used.
   c. Charts of accounts with definition or explanation of accounts.
   d. Design of complete programs of cost accounting with forms, procedures, etc.
   e. Actual installation and in some cases supervision of accounting operations.
7. Cost studies to determine average or representative cost of products, functions, or activities for general information of members.
8. Regular collection and dissemination of cost data under some kind of reporting plan.
9. Complete analyses of cost data to interpret results, to show trends, weaknesses of operation, etc.

All or any of these activities may be carried on by a given trade association All are interrelated, and the activity of one type normally encourages activity in another. For example, the collection and dissemination of **cost statistics** encourage inquiries into the bases of these costs. These inquiries involve a consideration of definition of terms, items included, methods or principles followed, and in many cases lead to the adoption of organized cost systems for the use of members. Moreover, activities primarily of a nonaccounting nature may give rise to accounting implications which provide an impetus to further developments of a uniform cost program.

COST MANUAL. In those cases where a uniform cost program is in effect, there is some document, bulletin, or more elaborate manual which is called the "cost manual." This represents the formal evidence of the **cost plan** recommended and describes the nature and scope of the particular plan. The contents depend upon the type and scope of the cost plan, upon methods of presentation preferred by those who devised the actual plan, and upon the extent to which it is believed the need exists for educational material relative to cost accounting and even general accounting.

Purposes of Cost Manual. The Chamber of Commerce of the United States (Developing the Uniform Cost Manual) covers the important features of good cost manuals and states the purposes of such manuals as:

1. Selling appeal; i.e., they should present in an interesting way the compelling reasons for the desirability of making use of uniform methods.
2. Serving as a comprehensive reference book on accounting procedure.
3. Usefulness to the executive and accountants in solving problems of installation of the recommended uniform methods

Physical Characteristics. Some questions to be considered in preparing a cost manual are those of size, binding, printing, character of paper stock, and size and arrangement of exhibits. A **printed manual** has the advantage of being more easily read, requires less paper than mimeographing, and makes it possible to set up material in more attractive style. A **looseleaf arrangement** is often preferred, either with a ring binder or a binder employing posts or rivets and supplied with substantial fabric or leather covers. The size of the sheet may well be the standard correspondence size of 8½ by 11 in. **Paper stock** should be of good quality, able to withstand considerable handling. Folded exhibits are frequently necessary. Their number should be kept as small as possible.

Scope of Manual. If the industry consists of companies of similar size and a common range of products, it is entirely feasible to present the accounting procedure in one manual for use of all members. Where, however, there is great disparity in size of companies in an industry, the better plan is to issue a separate manual for large companies and one for the small.

Character and Arrangement of Material. The material may be presented in various ways:

1. Descriptive method
2. Step-by-step method.
3. Handbook method

Under the **descriptive method,** the material is presented according to some logical accounting sequence, nontechnical and technical description being interwoven. This plan makes for readability, and while likely to require more printed

pages, is frequently the easiest and most satisfactory to follow on the part of the reader.

The **step-by-step method** refers to the plan of exposition by which each step in the installation and operation of an accounting plan is presented in the order that would be taken by the member making the installation. It is open to the objection that it is uninteresting and requires high concentration on the part of the reader.

By the **handbook method** the accounting material is presented in logical, concise accounting arrangement. Once the uniform system is installed, the handbook manual is of the greatest utility in that the accounting procedure may be quickly referred to and accounting problems readily solved.

Cost and Financial Exhibits. Forms of cost statements, balance sheets, income statements, and other similar exhibits are properly a part of a well-designed uniform cost accounting manual. Such exhibits must be thoroughly typical. By this is meant that the several exhibits should reflect conditions in the case of a member company. In some cases such exhibits have been prepared by the uniform cost accounting committee to show every conceivable item that could possibly appear. If the committee considers it wise to go into great detail with respect to the items found on the balance sheet, it would seem better practice to present the balance sheet in typical form and then in a supplementary exhibit to show the range of items that could conceivably be found.

Classification of Accounts. In most if not all uniform cost accounting manuals, it is found desirable to include a classification of accounts. In some cases this is simply a classification of representative overhead expense accounts. In other cases it is an extensive classification of all accounts, controlling and subsidiary, that are found desirable in any units of the industry. The following points should be covered:

1. Precise definition of important debits and credits to each account.
2. Suggested scheme of coding accounts, numerical, alphabetical, or mnemonic

ILLUSTRATIVE MANUAL MATERIALS.

Industry manuals containing uniform accounting systems are generally very adequate, both in their scope and in presentation of detail. Materials presented here only suggest the great wealth of information to be found in these manuals.

Statement of Objectives. The Uniform Accounting Manual for the National Electrical Manufacturers Association presents a definitive statement concerning the purpose of a uniform accounting manual:

> In order that the industry may be informed of the many accounting developments in recent years, especially in the field of cost accounting and analysis, the NEMA Industry Accounting Committee has published this Seventh Edition. The new edition has been completely revised both in context and presentation, and new material has been added so that electrical manufacturers may have available for their use and guidance a current accounting manual. It has been limited to broad principles which will provide the framework for developing sound accounting practices.
>
> This Seventh Edition of the Uniform Accounting Manual was designed to help and encourage companies in the industry by their voluntary action to establish more accurately the real costs of doing business, both as to individual products and total operations, as well as to estimate costs of new business; to determine sound inventory values and financial results from operations; and to present such informa-

tion in a clear and informative manner for the better control and guidance of the various divisions of the business.

Table of Contents. Both the detail involved and the broad scope of a uniform accounting system are demonstrated by the contents of the MAPI Accounting Manual:

Coding of Accounts. The decimal coding plan used in the accounting manual of the Machinery and Allied Products Institute was illustrated earlier in this section under Decimal Coding System.

Account Descriptions. The Uniform System of Accounts for Pipeline Companies prescribed by the Interstate Commerce Commission contains a complete **chart of accounts** and detailed explanations and descriptions of accounts to be used, such as:

29.8 **Cash.** (a) To this account shall be charged all cash received and to it shall be credited all cash actually paid out. The term "cash" includes metallic money, bank bills, legal tender, notes, checks, or other representatives of money.

(b) This account shall be so kept as to include in the balance of the account the actual amount in the carrier's general cash fund including the amounts held in its treasury, amounts deposited with banks and trust companies subject to check, and cash in deposit from agents.

20.73 **Operating reserves.** (a) This account shall include ledger balances representing reserves created by charges to operating expenses for the maintenance of carrier property, personal injuries, injuries and damages, and other claims, such charges being made currently for the purpose of equalizing the charges to operating-expense accounts for the current year. (See par. 20.0–79, Equalization of expenses.)

20.0–36 **Cost of construction.** The cost of the construction of property chargeable to the carrier-property primary accounts shall include the cost of labor, material and supplies, special machine service, transportation, contract work, protection, injuries and damages, cost of privileges and permits, taxes, rent, interest during construction, and other analogous elements in connection with such work, including costs for preliminary work such as sinking test holes or making soundings for buildings and other structures.

The several items of cost here referred to are defined as follows:

(a) "Cost of labor" includes . . .

20.423 **Bad debts.** This account shall be charged with receivables, which after a reasonably diligent effort to collect, are determined to be uncollectible.

Cost Classifications for Government Contracts

NATURE OF CONTRACTS. Because of wars and threats of wars, the selling of large quantities of naval and military supplies and equipment to the federal government of the United States has been for many years an important activity of American industry. Much of this material is manufactured by private firms in accordance with **government specifications.** These products often are new and quite different from the regular commercial product of the manufacturer who undertakes their production. To ensure that the goods necessary for national defense will be supplied in good condition, in sufficient quantities, and when needed, it is necessary for government officials to be able to make arrangements with manufacturers which will protect the manufacturer against loss, in view of the unusual risks involved in manufacturing these goods. On the other hand, there is a strong feeling that industry should not be allowed to make excessive profits on these goods needed for national defense. On many of these contracts the price is therefore set in relation to cost.

From World War II on there has been a series of laws, executive orders, departmental regulations, and memoranda dealing with costs and profits on government contracts. **Treasury Decision 5,000,** issued in 1940, was one of the more important of these. It was promulgated to recapture profits in excess of those permitted by the Vinson-Trammel Act on contracts for navy vessels and army and navy aircraft. Section 26.9 of Treasury Decision 5,000 sets forth in some detail the **types of costs** that were allowable or reimbursable on government contracts and subcontracts. The Contract Audit Manual (Army, Navy and Air Force) states:

> In the absence of any more authoritative and satisfactory publication, T.D. 5,000 was used as a basis for cost determination in most Army cost-type contracts during World War II and thereafter until Section XV Armed Services Procurement Regulations became effective. . . . Substantially all contracts based upon T.D. 5,000 have been completed.

In effect, T.D. 5,000 was superseded by the Contract Audit Manual and Armed Services Procurement Regulations. Of particular interest in the latter is Section VIII (Termination of Contracts) and Section XV (Contract Cost Principles). Cost-type contracts and subcontracts executed by the military departments on and after March 1, 1949, are subject to the cost principles of Section XV. In general, the Armed Services Procurement Regulations list **allowable costs** and

unallowable costs and discuss methods of allocating **indirect costs and expenses.** Running through the government regulations and interpretations is the idea that a contractor is not restricted to a particular cost accounting system as long as he uses one that is in accordance with generally accepted accounting principles and practices and which will produce records that may be verified and audited.

TYPES OF CONTRACTS. The Armed Services Procurement Regulations classifies **procurement contracts** into:

1. Fixed-price-type contracts.
   a. Firm fixed-price contract.
   b. Fixed-price contract with escalation.
   c. Fixed-price contract providing for redetermination of price.
   d. Fixed-price incentive contract.
2. Cost-reimbursement-type contracts.
   a. Cost contract.
   b. Cost-sharing contract.
   c. Cost-plus-a-fixed-fee contract.
   d. Cost-plus-incentive-fee contract.
3. Other contracts.
   a. Time and material contract.
   b. Labor-hour contract.
   c. Letter agreement.
   d. Basic agreement.

As contrasted to the **cost reimbursement contract,** cost plays a lesser role in the **fixed-price contract.** In fixed-price contracts, "cost and accounting data may provide guides for ascertaining fair compensation but are not rigid measures of it." The problem of **cost classification** takes on increasing importance as types of contracts depart from a firm fixed price to fixed-price contracts providing for various adjustments and to cost reimbursement-type contracts (Armed Services Procurement Regulations):

The cost-reimbursement type of contract provides for the payment to the contractor of allowable costs incurred in the performance of the contract, to the extent prescribed in the contract. This type of contract establishes an estimate of the total cost in the performance of the contract, to the extent prescribed in the contract. This type of contract establishes an estimate of total cost for the purpose of (i) obligation of funds, and (ii) establishing a ceiling which the contractor may not exceed (except at his own risk) without prior approval or subsequent ratification of the contracting officer. A cost-reimbursement-type contract may also provide for predetermined fixed overhead rates, usually to be redetermined at stated intervals.

Other types of contracts, particularly the time and material and labor-hour contracts, both of which are essentially cost-reimbursement-type contracts, rely upon careful classifications and computations of cost.

Costs in Terminated Fixed-Price Contracts. Costs contemplated by the Defense Department in the termination of a fixed-price contract are **direct costs,** those which are obviously essential to its performance, such as material and labor costs, and **allocable, allowable, indirect costs.**

Indirect costs include manufacturing overhead and general and administrative expenses not directly traceable but which may be apportioned in part to the contract. The Armed Services Procurement Regulations warns that where certain costs commonly treated as indirect are directly related to the contract, they must be eliminated from the computation of the overhead rate or rates.

Trueger (Controller, vol. 26) says:

. . . it should be recognized that the only official pronouncements as to unallowable costs appear in ASPR, Section VIII, pertaining exclusively to terminated contracts, and ASPR, Section XV, applicable to cost reimbursement-type contracts. Hence, there is no legal or contractual basis for citing any costs unallowable in the redetermination of fixed-price contracts. However, military auditors have always used the principles of ASPR, Section XV, as a guide in auditing fixed-price contracts This in effect means that the auditors have recommended for disallowance under fixed-price contracts those costs which were held to be unallowable only for cost-type contracts.

REDETERMINATION AND RENEGOTIATION. In some contracts there is a provision for price redetermination. This is an administrative procedure of the military department which has the contract. Profits that are determined to be excessive are returned to the department either through a reduction in price or by a refund.

Renegotiation is an entirely separate procedure. The Renegotiation Act, first passed in 1942 and amended and extended a number of times since, requires that certain governmental suppliers render a yearly report to the Renegotiation Board in which incomes and expenses are segregated between government contracts and the other business of the firm. Such profits as the Renegotiation Board, operating under its own regulations, determines to be excessive on the government contracts are returned to the Treasury of the United States rather than to the military department which awarded the contract.

REGULATION CHANGES. It seems likely that for many years to come the federal government's direct and indirect expenditures for national defense will continue to run into many billions of dollars each year. Probably government contracts will continue to constitute a substantial part of the business of many companies. The government regulations and the interpretations thereof concerning costs and profits on government contracts have changed over the years and presumably will continue to do so. No attempt is therefore made in this Handbook to go into detail on the regulations in force at present. Cost accountants who have responsibility on government contracts will find it advisable to keep informed on the new regulations and rulings as they are made.

SECTION 3

BASIC COST RECORDS

CONTENTS

CONTENTS (*Continued*)

SECTION 3

BASIC COST RECORDS

Factory Books and Records

INFORMATION REQUIRED BY MANAGEMENT. The essence of a satisfactory cost accounting system lies in the information obtained from the books and records that make up the system. The design of a **system of cost records** therefore depends largely on the results and information it is intended to provide: i.e., in planning the system, it is essential to consider the information required by management and then to design so that it furnishes exactly that information. If complete and detailed **historical cost** information is to be provided for a number of products, the system is necessarily extensive. If it is to be used principally as a device for control and reduction of costs (as is the present trend), **predetermined or standard costs** are used. All information regarding the product, plant, production processes, etc., should be considered in terms of its contribution to the type of cost system desired by management. But regardless of the type of cost system wanted by management there are four **cost system prerequisites**; the cost system must be: (1) accurate, (2) flexible, (3) simple, and (4) economical to operate.

Another important consideration for those who work with the cost system lies in the **physical characteristics** of individual records themselves. Ledger sheets, inventory cards, time cards, and other forms that are handled daily should be of substantial stock to withstand much wear and tear. They should be easy to post to and easy to understand. Printed forms should be designed to permit maximum use of duplicating devices where more than one form originates from one operation.

Bennett (Standard Costs) indicates the **objective** of the use of books and records:

> The accounting plan must provide the means for continuous recording and controlling of the financial transactions of the business, in an efficient and effective manner Furthermore, it must provide the machinery for so controlling and proving the work of the cost systems through the media of the financial books of account that monthly statements of profit and loss by product and the essential supporting analytical operating-detail information can be prepared readily and accurately.

Books and records of account, therefore, are the media through which financial transactions and cost data are accumulated for reports on which management planning and control can be based.

DOUBLE ENTRY APPLIED TO COST KEEPING. The information required under a cost system is obtained by an extension of the double-entry bookkeeping rules of debit and credit. Double-entry bookkeeping is based upon the fundamental principle of accountability for costs. This means that if one

dollar in cash is spent for material or service, the new cost received must be recorded, and the cost disposed of must likewise be recorded. An **exchange of costs** takes place with the disposition of an old cost for a new cost.

Cost accounting, as a division of accounting, follows the same fundamental rules in accounting for costs pertaining to factory operation. Moneys are expended, and in return materials, labor, and services classified as expenses (such as power, heat, and the like) are received. At this point, cost accounting begins. Specific accounting procedures must be provided for recording the acquisition and disposition of materials, for recording the employment and use of labor, and for recording the incurrence and distribution of expenses. Additional documents concerning operating activities must be prepared and recorded in the **books of original entry.** These books must be increased in number and be specially ruled to facilitate debit and credit recordings. Additional ledger **control accounts** are required, and these in turn require the use of additional **subsidiary ledgers** in which the cost accounts may or may not be ruled in the conventional manner. New forms of business papers or documents, journals, and ledgers must be developed in accordance with the requirements of the plant and the needs of management. Tendencies toward standardization may be noted here and there, but generally speaking, there seems to be a noticeable lack of uniformity in the design of documents, journals, and ledgers used in cost accounting systems.

BOOKS OF ACCOUNT. Under a cost system, cost transactions are recorded through cost controlling accounts which may be kept in the **general ledger** or segregated in a **factory ledger.** Special records are used in the form of journals as well as ledgers.

Journals. If cost transactions are not summarized for recording in the general journal, they may be entered in separate journals prior to posting to ledgers. Separate journals may be used to record material requisitioned, labor used, and overhead apportioned. In lieu of using a number of journals in which to enter costs, the system may provide for recording and accumulating all manufacturing costs in one factory or manufacturing journal.

Another method is to accumulate information on specially designed summaries which serve as a basis for **journal vouchers** at the end of the month. Such vouchers are then entered and posted directly through the general journal, or a factory journal where a factory ledger is used.

Ledgers. In addition to a general ledger and the usual subsidiary ledgers of financial accounting, many additional subsidiary ledgers may be found in a cost system. These may include a stores ledger, a finished-parts ledger, an overhead manufacturing-cost ledger, a plant ledger, a work-in-process ledger, and a finished-goods ledger.

In some systems **controlling accounts** for these ledgers appear in the general ledger. The cost system, however, may provide for a Factory Ledger Control account, thereby eliminating a number of control accounts from the general ledger.

CENTS-LESS OR WHOLE-DOLLAR ACCOUNTING. Before choosing the method of operating the various books of account present in a financial and cost accounting system, consideration should be given to the possibility of incorporating cents-less or whole-dollar accounting into the system. Barnard (NAA Bulletin, vol. 36) states that, "Whole Dollar Accounting is a technique applied to general accounting procedures through which the pennies (last two digits) of dollars and cents amounts are eliminated and amounts are recorded in whole dollars."

Application. Barnard (NAA Bulletin, vol. 36) emphasizes that:

Whole-dollar accounting does not apply to primary accounting. Examples of primary accounting are the recording of cash receipts and disbursements, receivables, payables . . . Whole-dollar accounting cannot be applied in these cases because third parties are affected. Likewise, it cannot be used in multiplying and dividing. It can be used in secondary accounting. Examples of secondary accounting are journal entries, sales analyses, expense distributions, cost allocations, prorations, statistical reports, or financial statements, inventory summaries, fixed assets, work sheets, listings, and products or quotients in calculating.

Advantages. The following advantages of "cents-less" or whole-dollar accounting are claimed by proponents, according to May and Klingman (Whole-Dollar Accounting):

1. Reduction in physical work (in the motion-time sense) required for:
   a. Recording and posting to accounts.
   b. Transcribing, computing and totaling, analyzing, and tabulating accounting data.
   c. Balancing and closing the books.
2. Increased productivity of accounting and related operations reflected in one or more of the following ways:
   a. Increased output per employee-time unit.
   b. Improved quality of output.
   c. Actual reduction in clerical costs.
3. Reduction in incidence of errors, and when an error is made, greater facility in locating, identifying, and correcting it. All companies having had "normal-run" experience with whole-dollar accounting report this as a significant gain.
4. Statement and report preparation time is reduced as a result of the compounding effect of the preceding factors. This means that management gets statements and reports earlier than was possible before.
5. Improved, more effective statements and reports.
   a. Simplification of data through eliminating the penny detail makes for less crowded, less cluttered, more readable reports and statements.
   b. Dropping insignificant digits in statements and reports (which invariably follows from whole-dollar accounting) helps management identify more readily the significant items and relationships among the data contained in reports.
6. Effective capacity of existing report and record forms is increased by eliminating two-penny digits in each column or series (or two digits plus decimal point). This makes available space for inclusion of additional, significant series without increasing the size or complexity of the report or record form. Conversely, should additional series be unnecessary, reports and records forms can be simplified in design and reduced in size.
7. Morale of accounting, statistical, and other personnel affected is materially improved.
8. Finally, all concerned cite as a distinct advantage the fact that the whole-dollar accounting concept and technique are simple. Compared with many other system and procedure changes, this makes it relatively easy to install successfully.

Limitations. According to May and Klingman (Whole-Dollar Accounting), critics of whole-dollar accounting have advanced the following disadvantages or limitations:

1. Whole-dollar accounting connotes abandonment of the double-entry principle in accounting.
2. It will result in loss of control and will open wide the door for encouragement of "plugging" by unscrupulous bookkeepers and accountants.

3. Whole-dollar accounting will have a bad effect on employees' attitude in the sense that it will:
   a. Encourage carelessness and inaccuracy in accounting operations.
   b. Cause more, rather than fewer, errors to be made in accounting operations because of the necessity for "rounding" to a full dollar.
4. Rounding to the nearest dollar will result in serious cumulative variances.
5. Whole-dollar accounting will cause more trouble and work than it will save.
6. Whole-dollar accounting may cause difficulties with governmental agencies, notably taxing authorities and regulatory bodies.
7. Mathematical difficulties and limitations:
   a. The percentage variance (or error) in the difference between two numbers may be considerable, as a result of the rounding technique, whereas the percentage variance, or error, induced by rounding each of the two numbers being differenced would be insignificant.
   b. The absolute distortion or variance resulting from extending unit prices or unit costs multiplied by large quantities will likely prove to be intolerably large. Therefore it is best that unit prices and unit rates be carried to just as much refinement or degree of accuracy as ever.

May and Klingman (Whole-Dollar Accounting) state further on the basis of their own experience that:

It must, in all honesty be reported that all of our on-the-spot research, as well as diligent search in other published reports of actual experience with whole-dollar accounting, has failed to produce any experience of basic weaknesses or disadvantages inherent in the whole-dollar accounting idea. There are some disadvantages which are theoretically possible of realization, but in all the cases of experience known to us—and this goes extensively beyond the cases included in this book—virtually all these potential disadvantages failed to materialize and, in one or two instances where they did, corrective action promptly eliminated them and, therefore, they have not become effective negatives in the working of whole-dollar accounting.

As a general rule, it would seem that if the use of cents-less or whole-dollar accounting would not materially impede accuracy and would enhance the flexibility, simplicity, and economies of cost system operation it should be considered seriously for adoption.

BASIC DOCUMENTS. Records and documents supporting **historical cost transactions** entered in journals and subsequently posted to ledgers are those relating to:

1. The acquisition, storage, and use of raw materials, parts, and supplies.
2. The employment of labor, activities, payrolls, etc., and the use and performance of labor.
3. The incurring, distribution, and allocation of manufacturing overhead to cost of production.

Documents falling into the first category would be, for example, purchase requisitions, purchase orders, receiving reports, summary of materials used, etc.; the second category includes job or time tickets, clock cards, payroll journal, employees' payroll records, etc.; in the third category the information would come from invoice vouchers, journal vouchers, material requisitions, etc. Specific examples of the various documents are included in the appropriate sections of this handbook.

FACTORY ORDERS. A factory order is an authorization to the factory to commence specified operations. It is usually in written form so that misunderstanding as to specifications, purpose, time limitations, etc., may be avoided. The most common factory order is the so-called **production order,** the two terms

being frequently used synonymously. Occasionally it may also be designated as a **work order or manufacturing order.** In continuous process or mass production plants, the number of such production orders is limited; in job order plants, the number of production orders is usually much greater.

A **classification of production orders** prepared by Blocker and Weltmer (Cost Accounting) includes:

1. Orders for custom-made or special-order production for customers.
2. Orders for products and parts manufactured for stock.
3. Orders for parts or machines for plant use.
4. Orders for repairs to products for customers or repairs to plant machinery.
5. Orders for reconditioning of defective work.

Work orders may also be issued to the factory to do some **research and development** work or other special work.

Production orders should specify materials to be used, routing of the material through the factory, number of units of product to be manufactured, date to be completed, and whether for stock or for a customer.

Proper **scheduling of work** through issuance of production orders is a feature of cost control. During slack periods repair orders, betterment orders, and experimental work orders may be utilized to keep men and machines busy. Production orders should be scheduled so as to eliminate the piling up of work in some departments and lack of work in other departments.

The form of the production order is not standardized. Bennett (Standard Costs) illustrates in Fig. 1 a typical manufacturing or factory order which could

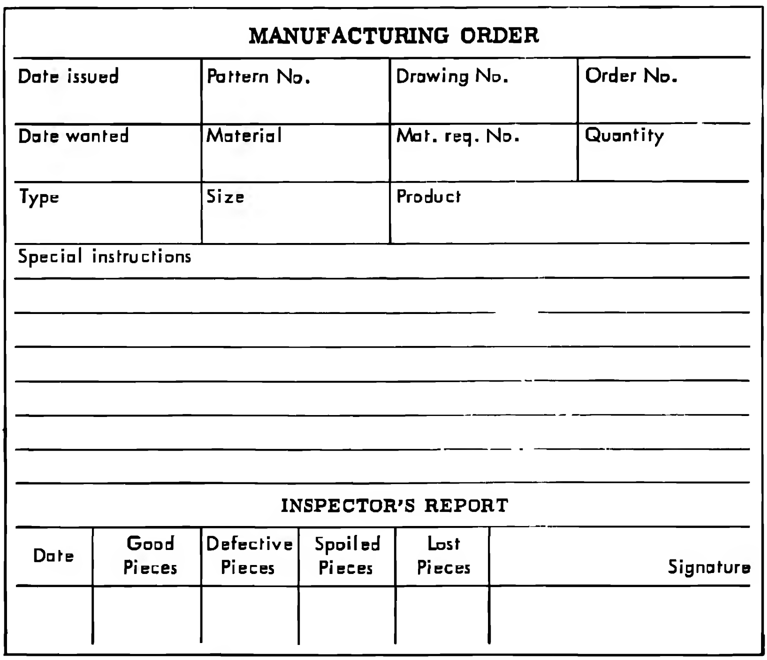


Fig. 1. Manufacturing or factory order form.

be used to authorize the manufacture of a machined part. For further illustration and discussion of production orders, see section on Job Order Cost Systems.

COST SHEET. A cost sheet is a statement which shows costs incurred or allocated to each factory order, whether for stock, for a customer, or for some other purpose. Its object is to indicate the cost of material, labor, and manufacturing overhead entering into the product or used in a manufacturing process. Cost sheets are also used to assemble costs assignable to factory repair orders, betterment orders, or to experimental work orders.

The **cost sheet form** and the kind of information contained thereon depends upon the nature of activities of the plant, needs of the management, and the degree of control exercised over cost figures. For illustration and further discussion of cost sheets, see section on Job Order Cost Systems.

THE VOUCHER SYSTEM. One of the most successful methods of controlling the disbursement of cash and the classification of the cause of the disbursement is a voucher system. The Accountants' Handbook (Wixon, ed.) states the purposes of a voucher system as:

1. To provide economy in handling and recording purchase of goods or services.
2. To provide means for correct charges to accounts representing purchases of goods or services.
3. To secure specific receipts for specific invoices in order to
   a. Minimize fraud.
   b. Avoid double payment of same bills.
4. To secure control over volume of disbursements.

The operation of voucher systems is described in detail in the Accountants' Handbook (Wixon, ed.).

The voucher system used in a mercantile or trading type of enterprise, however, must be adapted to fit the needs of the cost accounting systems used by manufacturing companies. Neuner (Cost Accounting) states:

> Since the transactions of a manufacturer differ somewhat from those in a mercantile firm, the columnar headings in the Voucher Register will also differ. . . . For a manufacturing concern which does not maintain a separate Factory Ledger, and yet whose cost accounting system is tied in with the regular financial accounting records, the Voucher Register should have columns for the following:

Accounts Payable, Credit	Stores, Debit.
	Payroll Accrued, Debit.
	Manufacturing Overhead Control, Debit.
	Selling Expense Control, Debit.
	Administrative Expense Control, Debit.
Sundry Accounts, Credit	Sundry Accounts, Debit.

Cost Controls and Subsidiary Ledgers

CONTROL ACCOUNTS. A controlling account is an account kept in a major ledger whose balance represents in a single sum the details contained in two or more accounts of the same nature as the control but which are kept in a subsidiary ledger. Postings to detailed accounts in a subsidiary ledger must ultimately be reflected in postings to control accounts, which are usually lump sum postings made at the end of a period.

Matz–Curry–Frank (Cost Accounting) illustrate important **cost controls** and their respective **subsidiary ledgers** in Fig. 2.

Control Accounts	Subsidiary Records
Stores	Store cards, perpetual inventory.
Payroll	Time cards, employee records.
Manufacturing Overhead Cost	Cost ledger and departmental cost analysis sheets.
Work in Process	Production reports, process cost system. Cost sheet, job order cost system.
Finished Goods	Finished-goods ledger cards.
Machinery and Equipment	Plant ledger.

Fig. 2. Cost control accounts and their subsidiary ledgers or records.

Controlling Account–Subsidiary Relationships. Indiscriminate use of controlling accounts can be as much a hindrance as a help. In order to avoid such a result, Blocker & Weltmer (Cost Accounting) suggest several general principles of controlling account–subsidiary relationships as found in cost accounting:

1. It is usually advisable to use a controlling account when detailed information can be compiled in records supplementary to the general ledger. For example, overhead costs may be analyzed in work sheets which may serve as subsidiary records for the Factory Overhead Control account.
2. A controlling account with supporting subsidiary records is advantageous when the accounting system is decentralized, i.e., when detailed accounting is done in factory offices or branches apart from the general accounting office.
3. Subsidiary cost records may be in a variety of forms: bound or loose-leaf ledger accounts, card files, columnar analysis sheets, and such business papers as time tickets, payroll sheets, production orders, and expense vouchers.
4. The plan of operation is to have an account in the general ledger designated as a controlling account for a group of accounts; subsidiary record forms are devised; daily transactions are analyzed and posted to subsidiary records either from detailed entries in journals or, more frequently, directly from original business papers such as invoices, payrolls, time tickets, and vouchers. Posting of totals of the transactions of the period are made weekly or less frequently to the controlling account in the general ledger from journals or from summary statements of transactions The balance of the controlling account is proved monthly or more frequently against the sum of the balances of the subsidiary records which it controls.

In Fig. 3, Neuner (Cost Accounting) shows the relation of three important control accounts to their respective subsidiary ledgers for a **job cost system.**

Advantages of Controlling Accounts. In addition to the aforementioned principles of controlling accounts, Blocker and Weltmer (Cost Accounting) list five advantages of using controlling accounts:

1. Controlling accounts are invaluable to management in policy formulation because they summarize masses of detailed information contained in subsidiary records.
2. Controlling accounts make possible a division of labor among clerks and accountants and a greater degree of specialization in work performed.
3. A system of internal check exists through the use of controlling accounts because the work of one individual is checked against the work of others. This is an important factor in assuring accuracy, maintaining honesty, and detecting errors.
4. The use of controlling accounts permits the prompt preparation of financial statements at the end of each accounting period without waiting for all work to be done in balancing individual subsidiary ledgers.

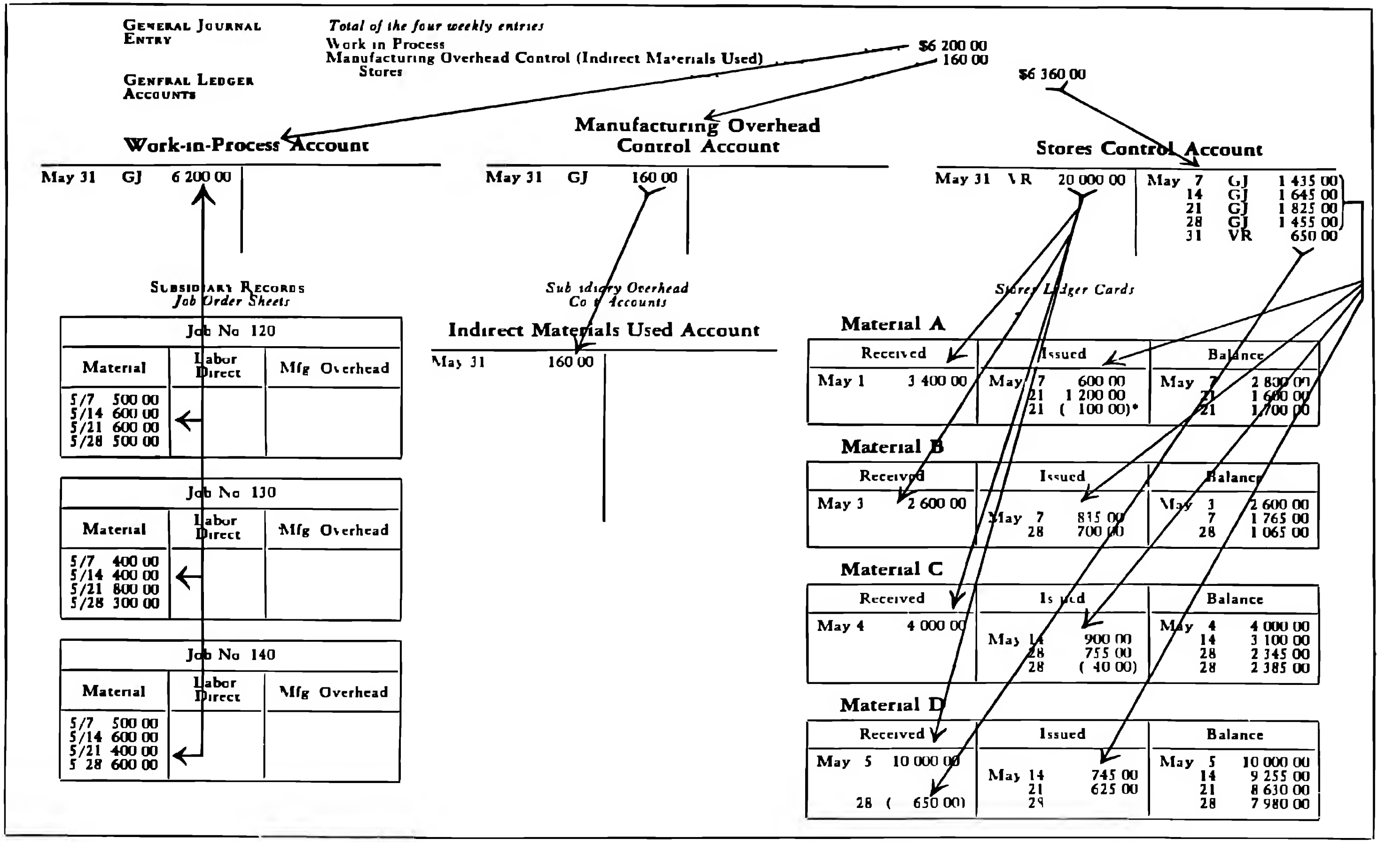


Fig 3 Relation of control ac ounts to their subsidiary ledgers for a job cost system

5. **Controlling accounts permit the general ledger to remain under executive control, and since the accounting system is decentralized through the use of subsidiary records, costs and the financial position of the concern may be treated confidentially.**

In general, accounts appearing in a **factory ledger** represent manufacturing control accounts. Some of these are not technically controlling accounts, since there is no subsidiary ledger to support them. This group of accounts is sometimes referred to as reflecting the **manufacturing cycle**, since the accounts are so arranged as to trace the **flow of costs** from raw materials through work in process, finished goods, and cost of sales. When finished goods are sold, new supplies of raw material are required to start a new cycle.

Principal Cost Controlling Accounts. The most important cost controls and their method of operation are given in the accompanying table.

Stores

Inventory at Beginning	Direct Materials Issued
Purchases	Indirect Materials Issued
Reclaimed Material	Returns to Suppliers
Scrap	Balance (Inventory at End)
Returns from Production	

Work in Process

Inventory at Beginning	Cost of Completed Production
Raw Materials Used	Finished Parts
Finished Parts Used	Finished Goods
Direct Labor Used	Spoilage and Reclaimed Materials
Manufacturing Overhead Applied	Return of Unused Raw Materials and Parts to Stores
	Balance (Inventory at End)

Finished Parts

Inventory at Beginning	Returns to Suppliers
Cost of Completed Parts from Work in Process	Issues to Work in Process (on Assembly Orders)
Cost of Completed Parts Purchased	Cost of Goods Sold (for Parts Sold Directly)
Returns from Production	Balance (Inventory at End)
Returns from Customers	

Finished Goods

Inventory at Beginning	Cost of Goods Sold
Cost of Completed Production	Balance (Inventory at End)
Returns from Customers	

Cost of Sales

Cost of Shipments to Customers	Cost of Returns from Customers
	Balance to Profit and Loss

Actual Manufacturing Overhead

Cost of Indirect Material Used	Transfer from Applied Manufacturing Overhead
Cost of Indirect Labor Used	Balance to Over- and Underapplied Manufacturing Overhead
Expenses Incurred Through Voucher Register	
Fixed Charges, such as Taxes, Insurance, and Depreciation	
Balance to Over- and Underapplied Manufacturing Overhead	

Applied Manufacturing Overhead

Closed into Actual Manufacturing Overhead	Estimated Cost Charged to Work in Process

SUBDIVISIONS OF WORK IN PROCESS. Subdivision of the Work-in-Process account may be on the basis of:

1. Elements of cost.
2. Departmental costs.

Where Work in Process is divided according to **elements**, Lang–McFarland–Schiff (Cost Accounting) show the accounts as follows:

Material in Process

DR.	CR.
With cost of material on hand at the beginning of the period	With cost value entered on the completed finished parts and finished goods orders; at the same time, debit Finished Parts and Finished Goods accounts.
With direct materials issued during the period for production orders; at the same time, credit Stores account.	With cost of materials returned to stores; at the same time, debit Stores account.
With finished parts issued during period for subassemblies and finished goods; at same time, credit Finished Parts account.	

The balance of this account represents the amount of materials in process, or **unfinished work,** and should agree with the **material costs** on various cost sheets of unfinished orders.

Labor in Process

DR.	CR.
With cost of direct labor in process at the beginning of the period.	With cost of direct labor on the completed finished parts and finished goods orders; at the same time, debit Finished Parts and Finished Goods accounts, respectively.
With direct labor applied to production orders during the period; at the same time, credit Factory Payroll account.	

The balance of this account represents the amount of **direct labor in process** and should agree with the sum of the direct labor section on the various cost sheets of unfinished orders.

DR. Manufacturing Overhead in Process	CR.
With applied overhead in process at the beginning of the period. With overhead applied to production orders during the period; at the same time, credit Manufacturing Overhead account.	With overhead applied to the completed finished parts and finished goods orders; at the same time, debit Finished Parts and Finished Goods accounts.

The balance of this account represents the amount of **applied overhead in process** and should agree with the sum of the manufacturing overhead section on the various cost sheets of unfinished orders.

The distinguishing features of **departmental work-in-process** accounts are:

1. A separate Work-in-Process account is opened for each cost center or department.
2. Interdepartmental transfers may be made by debiting the department receiving work and crediting the department from which work is transferred.

In all other respects these accounts are operated in the same way as a single Work-in-Process account; i.e., they are debited for direct material used, labor consumed, and overhead incurred in the particular department or cost center. Such accounts are particularly common in **process costs.**

TEMPORARY COST ACCOUNTS. Sometimes intermediate cost accounts are employed. They are transitional or temporary accounts, which are cleared out before trial balance time. Thus Schlatter and Schlatter (Cost Accounting), in an example of cost accounts for a cement mill, show the following temporary cost accounts:

1. Mill Overhead.
2. Coal Preparing.
3. Light, Power and Water.
4. Machine Shop.
5. Packing and Loading.

Use of such accounts may be advisable where **departmental work-in-process** accounts are employed. In such cases, accounts similar to those listed above are opened, and after being analyzed, their balances are closed into appropriate departmental work-in-process accounts through suitable journal entries.

GENERAL RECORDS AND COST RECORDS. Details of costs which appear in cost accounts usually are coordinated with the general books of the organization; otherwise lack of control may result and it may become impossible to determine whether cost records and reports have been prepared accurately. This can be remedied by dovetailing the cost records into the general records by means of controlling accounts. The diagram from Van Sickle (Cost Accounting), presented in Fig. 4, shows the **cost control accounts** required, their relation to each other and to the **general accounts.** Subsidiary ledgers furnish detailed figures to support each control account. The diagram may also be used as a **flow chart** of production costs.

Statistical Costs. The cost systems described in this section are sometimes known as **accounting cost** or **tied-in cost systems** because the cost accounts are an integral part of the accounting system of the company and are controlled by the general ledger. Although this is generally regarded as the more desirable

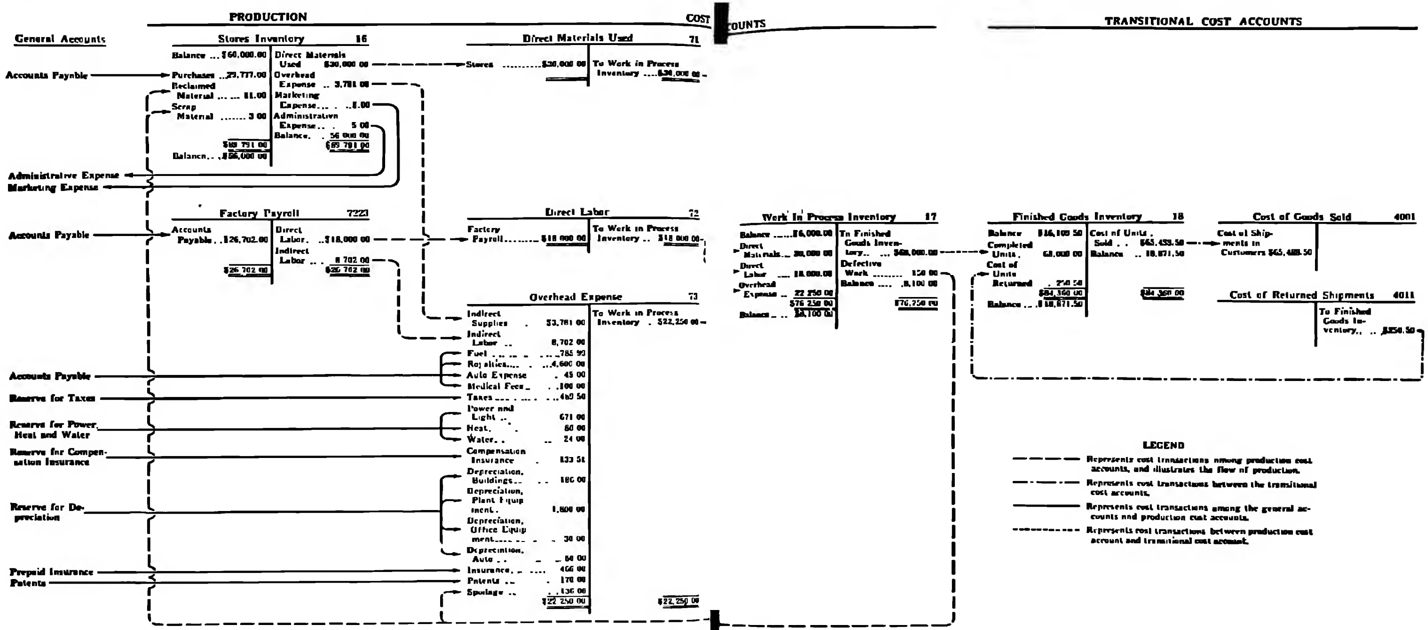


Fig. 4. Relation of general accounts to cost accounts.

arrangement, a number of small manufacturing companies use what is sometimes described as a **statistical cost system**. In this the cost accounts are kept separate from the general books and do not balance in with them. (For a discussion of the relative merits of these systems, see Tied-in Costs in the section on Cost Classification.)

SELECTION OF FACTORY RECORDS. The size of a company and its physical layout govern the selection of factory records. In small or medium-sized companies, the cost or factory records are subject to controlling accounts carried in the general ledger. In larger companies and companies with factory branches, **factory ledgers** are used to relieve the general ledger of carrying individual factory control accounts. The factory ledgers then contain individual factory accounts, such as labor, overhead, and other accounts under factory jurisdiction

Disadvantages of Single Ledger. The practice of keeping all control accounts in one general ledger involves disadvantages. These are stated by Lang–McFarland–Schiff (Cost Accounting) as follows:

1. The number of accounts in the general ledger becomes inconveniently large.
2. Preparation of the monthly statements may be delayed, since all figures must go through one ledger in order to appear eventually in the trial balance.
3. In large organizations with several factories it is common for the management of each plant to have a large degree of autonomy. A complete set of accounts is needed at each plant so that the management of the plant may have information it needs in order to operate most efficiently.
4. It may be desired not to entrust too much information to one person. A division of labor permits different persons to work independently on specific accounts which are kept under unified control through interlocking accounts.

FACTORY LEDGER. A factory ledger is a complete, self-balancing ledger coordinated with, rather than subordinated to, the general ledger. Hence a trial balance of accounts in this ledger is added to the trial balance of accounts appearing in the general ledger. Where a factory ledger is used, it is necessary to remove the cost controls from the general ledger and incorporate them in the factory ledger. In order to make both ledgers **self-balancing**, a new account is introduced in each ledger:

1. In the general ledger: Factory Ledger Control account.
2. In the factory ledger: General Ledger Control account.

The typical appearance of these **reciprocal accounts** is shown by Matz–Curry–Frank (Cost Accounting) in Fig. 5. Note that the debit balance in one account exactly matches the credit balance of the other.

HOME OFFICE BOOKS

Factory Ledger

(a)	60,000	(d)	1,000
(f-5)	48,280	(j)	142,000
(g-1)	5,000		
	6,000		
(g-2)	8,200		
(x)	10,520		

FACTORY BOOKS

General Ledger

(d)	1,000	(a)	60,000
(j)	142,000	(f-5)	48,280
		(g-1)	11,000
		(g-2)	8,200
		(x)	10,500

Fig. 5. Reciprocal accounts in factory and general ledgers. The letters (a), (f-5), etc., key the ledger entries in Fig. 5 to the journal entries in Fig. 6.

Accounts Appearing in Factory Ledger. If the General Ledger Control account is to be debited or credited as a result of a transaction, data must be reported to the home office or general accounting department in order that a reciprocal control entry may be made. If the factory control account upon the general books is to be debited or credited, the information must be recorded in the factory books, inasmuch as the controls must be in agreement at all times.

The most important accounts kept in the factory ledger are:

1. Stores.
2. Factory Supplies.
3. Finished Parts.
4. Direct Labor, if such an account is to appear.
5. Payroll Accrued.
6. Manufacturing Overhead, Actual.
7. Manufacturing Overhead, Applied.
8. Work in Process.
   a. Material in Process.
   b. Direct Labor in Process.
   c. Manufacturing Overhead in Process.
9. Finished Goods.
10. General Ledger Control.
11. Cost of Sales.
12. Additional accounts such as:
    a. Factory Petty Cash.
    b. Payroll Cash.
    c. Some operating reserves.

FACTORY JOURNALS. Factory journals are used as media for postings to the factory ledger. Fig. 6, adapted from Matz–Curry–Frank (Cost Accounting), shows a multi-column factory journal used to summarize **factory journal vouchers** or memos forwarded by the home office to the factory. Postings of amounts appearing in the factory journal are made in the usual manner to accounts appearing in the factory ledger and to accounts in ledgers subsidiary to the factory ledger. Where numerous entries come from many sections of the works accounting department, the columnar journal combines those entries and reduces the number of postings to each factory ledger account. The factory journal becomes an analysis of all manufacturing entries month by month, as well as being a book of original entry, and the ledger becomes mainly a "long time" book of control totals. Sometimes it is feasible to post accounts directly from journal vouchers, resulting in considerable system simplification and savings.

Some other journals which may be used at the factory are:

1. Requisition Journal.
2. Summary of Factory Disbursement Vouchers.
3. Finished Goods Journal.
4. Cost of Sales Journal.

Developing Forms and Reports

PURPOSE OF FORMS. For a cost accounting system to function properly, the physical media through which cost information is assembled must be carefully designed and coordinated. Neuner and Neuner (Accounting Systems) maintain that these physical media or **business forms** exist for three reasons:

1. To fix responsibility for creation, recording, or completion of business transactions.
2. To reduce the possibility of error by "putting it in writing."
3. To transmit essential information from one person to another within the same organization or in another firm.

A **receiving report**, for example, is a form that fixes responsibility, i.e., it indicates the number of articles of merchandise received from a vendor, and the responsibility for receipt of this number is accepted by the receiving clerk. The goods and a copy of the receiving report are taken to the stores clerk who acknowledges that he assumes responsibility for the merchandise listed on the report by signing it. The receiving report form also serves as a medium for transmitting information in that, upon proper routing, it informs the accounting department that certain goods were received and sent to the storeroom. One copy of the receiving report is used to support the voucher that pays the supplier's invoice. Another copy goes to the stores ledger clerk who uses it as the basis for posting to the receipts column of the proper stores ledger cards. The receiving report thus provides a written, receipted record which indicates the different responsibilities of the several persons involved in handling the transaction.

TYPES OF FORMS. Business papers may be classified in many ways, but in the final analysis there are three main types of forms:

1. Those that authorize or order action.
2. Those that record and/or approve action.
3. Those that both authorize and record action.

Page 2

FACTORY JOURNAL

Date	Explanation	General Ledger		Stores	
		Dr.	Cr.	Dr.	Cr.
(a)	Materials purchased		60,000	60,000	
(b)	Materials requisitioned				58,00(
(c)	Supplies requisitioned				4,00(
(d)	Materials returned to vendor	1,000			1,00(
(e)	Materials returned to storeroom			500	
(f-1)	Direct and indirect labor				
(f-3)	Employer's payroll tax liability				
(f-5)	Paying factory payroll		48,280		
(f-7)	Distribution of factory payroll				
(g-1)	Factory insurance and taxes		11,000		
(g-2)	Depreciation of building and machinery		8,200		
(h)	Manufacturing overhead applied				
(i)	Goods completed				
(j)	Goods shipped	142,000			
(x)	Transfer of payroll tax liability to office		10,520		
	Totals	143,000	138,000	60,500	63,00(

Fig. 6. Factory journal summarizin

Gillespie (Accounting Systems: Procedures and Methods) expresses the idea that:

Business papers are the papers used for making the first record of any transaction. They include (a) all of the forms produced inside the business to get a record of each transaction at the source, and (b) incoming papers that can be used as evidence of transactions. Some common original business papers, classified according to general function are:

1. Sales and cash-collecting function: sales or sales order invoice, cash receipts voucher, debit memorandum, credit memorandum.
2. Purchasing and cash payment function: request for purchase, request for quotation purchase order, receiving report, purchase invoice, purchase invoice apron, remittance advice, disbursement voucher, check, petty cash voucher.

FACTORY JOURNAL

Page 3

Mfg. O'head Control		Work in Process			Sundry			
Code	Dr.	Materials Dr.	Labor Dr.	Mfg. O'hd. Dr.	Account Title	LF	Dr.	Cr.
		58,000						
430	4,000							
		*500**						
					Payroll		56,000	
					Accrued Payroll			48,280
					F.I.C.A. Taxes Payable			1,120
					Fed. Inc. Taxes Withheld			6,600
422	1,120				F.I.C.A. Taxes Payable			1,120
422	1,512				State Unemploy. Taxes Payable			1,512
422	168				Fed. Unemploy. Taxes Payable			168
					Accrued Payroll		48,280	
412	18,000		38,000		Payroll			56,000
428	5,000							
429	6,000							
463	5,200							
460	3,000							
				28,875	Mfg. Overhead Applied			28,875
		*60,000**	*40,000**	*30,000**	Finished Goods		130,000	
					Finished Goods			142,000
					F.I.C.A. Taxes Payable		2,240	
					State Unemploy. Taxes Payable		1,512	
					Fed. Unemploy. Taxes Payable		168	
					Fed. Inc. Taxes Withheld		6,600	
	44,000	*60,500** 58,000	*40,000** 38,000	*30,000** 28,875			244,800	285,675

*Figures in italics are written in red ink or are written in black ink and circled.

factory journal vouchers.

3. Employment and payroll function: foreman's requisition for new employees, application for employment, authorization to place on payroll, separation report, attendance time cards, shop time records, pay check or envelope, pay stub or employee's earnings statement.
4. Production and inventory function: production order, bill of material, requisition, operation list, route card, job ticket.

Note that some of these papers (the order forms) are written in the first place to direct some one to do something that is indicated in the writing and to convey the authority for him to do it. . . . Others are in the nature of advice on transactions.

FORM DESIGN. Because of the nature of its work, the cost department is frequently called upon to design new forms or to redesign old forms. The principles set forth here apply equally to the design of report forms and to that

of accounting forms and other records. A review of the forms in use with illustrative entries is helpful whenever new or revised forms are contemplated as well as when reprinting. Frequently it is found that some spaces are not used, while other spaces are used for purposes not intended because no space was provided for the specific item.

The exact design depends on many factors; i.e., whether the forms are prepared for use manually or are designed to be used in connection with mechanical equipment. Specifically, the following **design requisites** are suggested by Heckert and Kerrigan (Accounting Systems):

> A form is really inseparable from the activity of people up and down the personnel ladder of an organization, from clerk to president.
>
> That is the reason why four out of five generally recognized requisites of a well-designed form bear on the relation of the form to the people. First, a form must create a favorable attitude in the person who contacts it. Secondly, a form must allow for the easiest possible entry of data. Thirdly, a form must permit the easiest possible use of its data. In the fourth place, a form must minimize human error in entering or using data in it. In the fifth place, a form should minimize the cost of paper and printing.

ARRANGEMENT OF MATERIAL. The information on the form must be arranged so that it is as clear, concise, and simple as possible. In appearance the form should be pleasing and should be so designed that a minimum of training is required in its proper use. The **title** and **identification number** ordinarily appear at the top. All **column headings** should be as clearly descriptive as possible. The **ruling** and **spacing** should provide adequate space for legibility.

When a form is to be filled in on the typewriter, it should be so designed that once it is adjusted to the proper position in the machine, the writing will fall automatically in the proper spaces without further adjustment. Proper **margin space** must be provided for any form adapted for use on a typewriter. Forms for other machines must, of course, conform to the mechanical requirements of the particular machine in question.

SELECTION OF PAPER. The quality of paper chosen for the various forms must depend upon the importance of the form and the amount of handling which the form must withstand. In this connection, Neuner and Neuner (Accounting Systems) state that:

> The American Paper and Pulp Association has made an attempt to standardize the **classification** of the various types of paper used. The papers used in printing ordinary business forms and their applications, are as follows:
>
> 1. **Rag bond** stands up better under handling because its fibers are stronger than wood fibers, and it presents a better appearance than sulphite paper, although it is more expensive. Its life is estimated at over twenty-five years.
> 2. **Sulphite bond** is generally used for most office forms. It has good appearance, stands up well under ordinary usage, and is relatively inexpensive. It is estimated that this paper will stand up for five to ten years.
> 3. **Ledger paper** is used primarily for systems work. It withstands erasing and creasing, and both sides may be ruled clearly and distinctively. Loose-leaf records should be printed on heavier paper than the bound-book type.
> 4. **Duplicating paper** is a general term descriptive of a group of lightweight writing papers such as onionskin and manifold papers. These are used for manifold or multiple copies such as are required for invoices, shipping tickets, receiving reports, and the like.

Neuner and Neuner also recommend that:

In addition to following these general rules about the quality of papers, a firm should standardize on ink colors and type styles, because uniform typography improves the appearance of the work and increases the legibility of the forms, which should reduce the number of errors arising in their use.

Each cuts without waste from standard sizes used by all printers.

Size of Form	Cuts Without Waste from Standard Sheet Measuring:	Number Obtained from Single Standard Size Sheet	Number of Single Forms Obtained from One Ream (500 sheets) of Paper
2¾ x 4¼	17 x 22	32	16M
2¾ x 8½	17 x 22	16	8M
3½ x 4¼	17 x 28	32	16M
3½ x 8½	17 x 28	16	8M
3½ x 17	17 x 28	8	4M
4¼ x 5½	17 x 22	16	8M
4¼ x 7	17 x 28	16	8M
4¼ x 11	17 x 22	8	4M
4¼ x 14	17 x 28	8	4M
4¼ x 28	17 x 28	4	2M
5½ x 8½	17 x 22	8	4M
5½ x 17	17 x 22	4	2M
6 x 4½	19 x 24	16	8M
6 x 9½	19 x 24	8	4M
6 x 18	19 x 24	4	2M
7 x 8½	17 x 28	8	4M
7 x 17	17 x 28	4	2M
8½ x 11	17 x 22	4	2M
8½ x 14	17 x 28	4	2M
8½ x 22	17 x 22	2	1M
8½ x 28	17 x 28	2	1M
9½ x 12	19 x 24	4	2M
11 x 17	17 x 22	2	1M
12 x 19	19 x 24	2	1M
14 x 17	17 x 28	2	1M

Bond and ledger papers are obtainable in 17 x 22, 17 x 28, 19 x 24, 22 x 34, 28 x 34, 24 x 38.

Fig. 7. Standard form sizes.

SELECTION OF FORM SIZE. The size of the form should be determined by the following factors:

1. Contents of the form. Ample space should be allowed for making entries without waste.
2. Size of binder, folder, or filing unit. Binders and filing devices are built in standard sizes. It is usually possible to design forms to conform to such sizes. Nonstandard devices are more expensive.
3. Proper size to cut economically from standard-sized sheets. Flat papers are manufactured in standard-sized sheets, and forms should be designed so far as possible to cut without waste from such sheets.

Fig. 7 shows the dimensions of individual forms which can be cut without waste from **standard flat papers.**

PRINTING SPECIFICATIONS FOR FORMS. In order to avoid confusion and misunderstanding, a carefully drawn copy of the form should be prepared, and detailed specifications should be made out for the printer. Fig. 8

FORM PRINTING SPECIFICATION

Form No.	KILT—53
Title	Requisition.
Trimmed Size	8¾ × 10⅞ in.
Paper Stock	Original Copy—No. 4 sulphite bond, 16#, White Duplicate Copy—No. 4 sulphite bond, 16#, Green. Triplicate Copy—No. 4 sulphite bond, 16#, Canary
Margins	Front: ¼ in. on 8⅝ in. top, ¾ in. on 10⅞ in left
Print	Black ink, one side.
Register	Form must register exactly in sets of three parts.
Number	Consecutively, all parts of sets.
Gather	Three sheets to a set in following order: White, Green, Canary.
Pad	Thirty-three sets to a pad, padded on 8⅝-in. top with chipboard backing.
Punch	No. of holes—2. Diameter and shape, ⅜-in. slitted holes, centered on 10⅞ in left. Center of holes 7/16 in. from 10⅞ in. left edge. Special, 7 in. center to center.
Wrap	In packages of five pads.
Samples	Send five samples of form to Forms Control Unit
Usage	Estimated usage, 1,000 sets annually.
Date:	November 30, 19__
Signature:	John Doe

Fig. 8. Printing specification sheet for forms.

illustrates a printing specification sheet, the use of which helps to avoid conflict with the printer. It is in the form of a folder, the inside of which is provided with **layout ruling** for the better preparation of the forms for the printer. **Printing instructions** concerning type face, size of type, etc., are inserted on the layout sheet.

CONTROL OF FORMS. Since a written form is the most used medium of company communication, the absence of forms control in a business may result

in less effective communication. According to the Office Management Handbook (Wiley, ed.), the underlying objective of a **forms control program** is to reduce the cost of paper work in the office and plant through the following:

1. Eliminate all unnecessary forms and their attendant clerical cost.
2. Prevent the inception of unnecessary new forms.
3. Consolidate all different forms doing the same thing.
4. Redesign forms for greater clerical efficiency and fewer clerical errors.
5. Reduce the amount of money spent for forms reproduction by selecting the most appropriate process.
6. Limit the distribution of forms to essential personnel only.

The Office Management Handbook also states:

> In attempting to reduce office costs through forms control and related paper work, management must realize that control over forms, procedures, and records is largely a means to an end and not an end in itself. The greatest economies of **paper-work control** are to be had through reducing the amount of clerical time required to process forms and the amount of management time required to use the forms and reports. An effective program therefore strives to increase the **productivity per worker** by making forms and procedures more efficient, thereby releasing minutes or hours of clerical and administrative time.

Heckert and Kerrigan (Accounting Systems) advocate the centralization of form control and list the functions of the **forms control unit** as:

> (1) To maintain an adequate forms file, (2) to clear all forms for ordering (or internal reproducing), and (3) to review, audit, and design forms.

Arnold (NAA Bulletin, vol. 40) states: "A forms control section reporting to the systems manager gives aid, advice, and service to all departments in order to achieve good forms design, economical forms procurement, and effective forms inventory management."

It is evident that it would be relatively impossible to fulfill the above functions if a specific unit were not given the responsibility for them. It is also doubtful if an ordinary operating department or company unit could efficiently become familiar with the myriad of requirements necessary for adequate form control. As Arnold (NAA Bulletin, vol. 40) points out:

> The one who first conceives a form is usually expert in something other than forms design, layout, and construction unless he happens to be a forms specialist. . . . He knows what the form will do for him and perhaps what it will cost his department to process it. Rarely, however, does he know what it will cost other departments that may have to handle it or exactly how it will affect the whole enterprise . . .

Centralized form control should result in three important savings:

1. Efficiency of effort. It will not be necessary for each department needing a new form to learn the many factors that must be considered if a functional form is to be designed.
2. Reduction of form costs. Little-used forms or copies of forms will be quickly discovered and discontinued unless they are necessary.
3. Constant form review will promote form modifications and therefore work simplification. Improved communications will also result, which will permit jobs to be completed more quickly and possibly at a lower cost

DESIGN OF COST REPORTS. Although form design is an important factor in any cost accounting system, the presentation of the cost data collected after they have been assembled and summarized by the cost system is also of vital

importance to the successful functioning of the system. *The entire problem of* reporting, including report design, is covered in the section on Cost Control, Budgets, and Reports.

Cost System Installation

NATURE OF PROBLEM. In the absence of a separate methods department, as in the case of form design, it often becomes the duty of the cost accounting department to initiate changes in the cost system. It may be that an entirely new system is required or merely a redesigning of parts of the existing system. A certain amount of revision always goes on, and the cost accounting department is usually called upon to take an active part in installing or revising the cost system.

Cost system **design and installation** are only part of a much larger job of organization, experimentation, and standardization of the entire plant. A cost system cannot operate satisfactorily in a poorly organized plant. The essential problem is to coordinate the production factors of material, labor, machines, and tools in order to secure a continuous flow of product in proper quantity and of proper quality. Hence a good cost system should be designed to tie in with a system of **production control.** Opinion, however, differs as to who is to design and install the system. Sometimes the job is done by an outsider, and sometimes it is developed from within. The outside accountant or industrial engineer should possess objectivity, special training in systems installation work, and possibly experience in installations for plants doing similar work. The factory man, however, has greater experience with, and more detailed knowledge of, the given plant, its processes, and its special problems.

Heckert and Kerrigan (Accounting Systems) indicate that the four major phases or steps in system building are: preliminary survey, design, installation, and follow-up.

STEPS IN SYSTEM INSTALLATION. Opinion differs as to the order of steps to be taken in systematizing a plant. Hodges (Management) maintains that the major **factors aiding control** include:

1. Analysis of the product.
2. Analysis of material.
3. Machine and equipment data.
4. Routing operations.
5. Scheduling operations.
6. Dispatching.
7. Standard times and methods.
8. Inspection.
9. Cost analysis.

It is to be noted that this listing seems to imply that **cost analysis** will function after all other factors have been properly systematized and standardized. The development of the factory controls listed, however, should take into account the kind of cost system to be introduced eventually.

SURVEY OF COST ACCOUNTING SYSTEM. The cost accounting system, to operate properly, must be an integral part of the general accounting system. In some companies the cost work is handled by the same persons as the general accounts, although in larger companies the cost department is a separate unit (see section on Cost Accounting Department). To ensure proper coordination between the cost system and accounting department, the existing set-up should be closely examined for both personnel and records. Heckert and Kerrigan

(Accounting Systems) outline a number of topics which should serve as a summary of the information needed in surveying the present accounting system. These are discussed in subsequent paragraphs here.

History. A complete knowledge of what has gone before serves to orient the systems man to what the company faces currently. It will shed light on the concern's age, position in the industry, rate of growth, and character of top management.

Products. Gathered under products are classification by-product lines, each of which is broken down to specific items and broken down further by sizes, styles, models, and other features. Customary units in which products are sold, factory unit cost, sale price, and similar factors are noted.

Chart of Accounts. By securing a copy of the classification of accounts in the general ledger and in each of the subsidiary ledgers, a handy reference is gained of the general framework of the accounting system.

Policies. A study of company policies will usually reveal considerable uncertainty as to what the actual policies are.

Organization. In studying organization, the object is first to understand how the present organization is supposed to function as called for by the official **organization manual** and the charts included in it. The second and more difficult step is to find out how the organization actually functions. To get the facts in the second step requires a combination of ingenuity, power of observation, and mechanical technique.

Plan of Production Processes. To be secured and studied are the charts showing (1) general layout and arrangement of the plant and (2) physical flow of production.

Existing Accounting and Office Procedures. The study of existing accounting and office procedures represents the "heart" of the engagement. This step in the survey narrows the inquiry and the accompanying gathering of facts to the technical procedures that are to be reviewed and improved.

The nature and scope of a survey to be made is fundamentally the same regardless of whether the occasion calls for work on a particular procedure only or on all procedures comprising the accounting system.

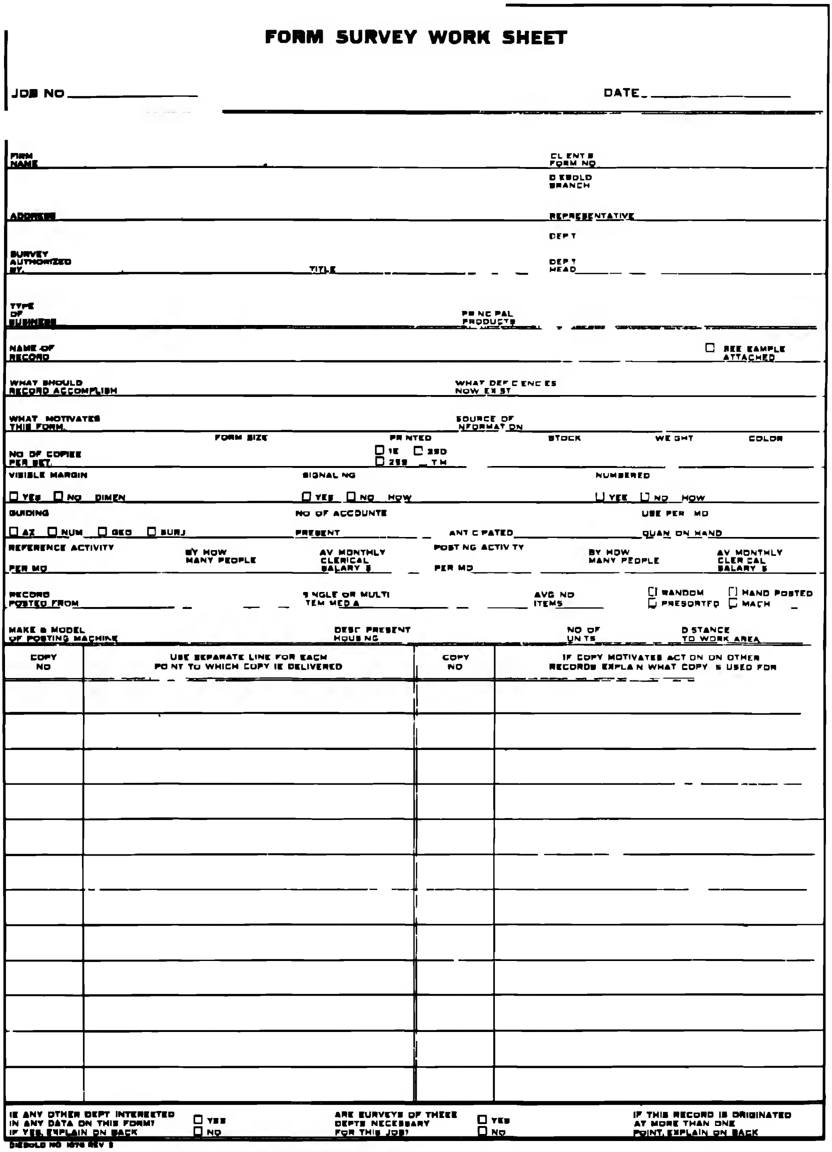
Forms and Charts for Survey. To carry out the work connected with the survey and the design of the new system, carefully prepared **work papers** are required. Gillespie (Accounting Systems) maintains that notes, work sheets, and charts in procedures assignment are useful:

1. As a means of organizing the data as they are gathered, controlling them so that the analyst can be certain that all parts tie together and no parts of the data are missing.
2. As a means of organizing the material for the use of the designer, particularly if he is someone other than the analyst, and for the analyst's supervisor. . . .
3. As a permanent file of the assignment to use as a record of work done and as a starting point for possible future assignments. . . .

Gillespie also lists the various **types of survey work sheets and charts** that are common to most systems surveys:

1. **Organization chart,** which includes the personnel who supervise the systems or procedures to be surveyed.

2. **Layout chart,** showing floor space and layout of facilities
3. **Forms work sheet** (see Fig 9)
4. Simple **operations lists,** which are lists of the clerical operations, taken down in the order in which they are performed on some major business paper and its related papers



FORM SURVEY WORK SHEET

JOB NO ____ DATE ____

FIRM NAME ____ CLIENT'S FORM NO ____
DIEBOLD BRANCH ____
ADDRESS ____ REPRESENTATIVE ____
DEPT ____
SURVEY AUTHORIZED BY ____ TITLE ____ DEPT HEAD ____
TYPE OF BUSINESS ____ PRINCIPAL PRODUCTS ____
NAME OF RECORD ____ ☐ SEE SAMPLE ATTACHED
WHAT SHOULD RECORD ACCOMPLISH ____ WHAT DEFICIENCIES NOW EXIST ____
WHAT MOTIVATES THIS FORM ____ SOURCE OF INFORMATION ____
NO OF COPIES PER SET ____ FORM SIZE ____ PRINTED ☐ 1ST ☐ 2ND ☐ 3RD __TH ____ STOCK ____ WEIGHT ____ COLOR ____
VISIBLE MARGIN ☐ YES ☐ NO DIMEN ____ SIGNALING ☐ YES ☐ NO HOW ____ NUMBERED ☐ YES ☐ NO HOW ____
GUIDING ☐ AZ ☐ NUM ☐ GEO ☐ SUBJ ____ NO OF ACCOUNTS PRESENT ____ ANTICIPATED ____ USE PER MO ____ QUAN ON HAND ____
REFERENCE ACTIVITY PER MO ____ BY HOW MANY PEOPLE ____ AV MONTHLY CLERICAL SALARY $ ____ POSTING ACTIVITY PER MO ____ BY HOW MANY PEOPLE ____ AV MONTHLY CLERICAL SALARY $ ____
RECORD POSTED FROM ____ SINGLE OR MULTI ITEM MEDIA ____ AVG NO ITEMS ____ ☐ RANDOM ☐ PRESORTED ☐ HAND POSTED ☐ MACH
MAKE & MODEL OF POSTING MACHINE ____ DESC PRESENT HOUSING ____ NO OF UNITS ____ DISTANCE TO WORK AREA ____

COPY NO	USE SEPARATE LINE FOR EACH POINT TO WHICH COPY IS DELIVERED	COPY NO	IF COPY MOTIVATES ACTION ON OTHER RECORDS EXPLAIN WHAT COPY IS USED FOR

IS ANY OTHER DEPT INTERESTED IN ANY DATA ON THIS FORM? IF YES, EXPLAIN ON BACK ☐ YES ☐ NO
ARE SURVEYS OF THESE DEPTS NECESSARY FOR THIS JOB? ☐ YES ☐ NO
IF THIS RECORD IS ORIGINATED AT MORE THAN ONE POINT, EXPLAIN ON BACK

DIEBOLD NO 1076 REV 1

Fig. 9. Forms work sheet

5. **Process charts,** which are used for taking down the clerical operations performed (as in the preceding paragraph), with the addition of symbols that identify the nature of the operations to facilitate study by the analyst.
6. **Forms distribution charts,** which are used for tracing separately the flow of each form and copy

GENERAL QUESTIONS

1 IS THIS FORM NECESSARY?	6 WHAT IF ANY PORTIONS ARE OBSOLETE?
2 ARE THERE ANY COMPLAINTS ABOUT THIS FORM OR ITS USE?	7 CAN SIZE BE CHANGED?
3 CAN IT BE COMBINED WITH ANOTHER FORM? (EXPLAIN)	8 WHAT ARE SIZE LIMITATIONS (MAX & MIN)?
4 WOULD IT BE ADVISABLE TO BREAK IT DOWN INTO TWO OR MORE FORMS? (EXPLAIN)	9 WILL FORM CHANGES AFFECT THE USE OF ANY MACHINE NOW IN USE?
5 WHAT IF ANY REVISIONS OR ADDITIONS ARE CONTEMPLATED?	10 HOW LONG DOES CLIENT RETAIN THIS RECORD? WHERE? HOW?

REMARKS

Diebold, Inc.

to aid system survey.

7. **Form charts,** which consist of copies of the actual forms, with illustrative entries.

MANUAL OF ACCOUNTING PROCEDURE. When forms have been designed and the new system is ready to operate, a manual of accounting procedures is written which gives the instructions for the execution of the various procedures and mechanics provided in the system. Many concerns use a manual or guide book which outlines the system in detail, complete with chart of accounts, lines of authority, priority in reports, etc. Such a book is very valuable to an accounting department. It has a high educational value for new employees, especially since it may eliminate misunderstandings in the department. A manual is best made up in loose-leaf form because from time to time changes are made in the system to fit changes in the manufacturing process and in the data required for executive reports. A copy should be given to all cost accounting department personnel.

Contents of Accounting Manual. Manuals of procedure may be classified as follows:

1. General handbook for employees.
2. Manuals of functional or departmental procedure.
3. Detailed performance and instructions.

The manual must set forth all necessary instructions pertaining to the accounting and statistical procedure as designed by the systems man.

Heckert and Kerrigan (Accounting Systems) illustrate the contents of an accounting procedures manual in Fig. 10. This is the general table of contents of a procedures manual prepared for a "concern doing business nationally through some 200 manufacturing plants scattered from the east to the west coast." In Fig. 11 these authors show a typical format of one account and the description of its related procedures in an accounting procedures manual.

COST SYSTEM CHANGE-OVER. Once the plan of cost records has been devised and the necessary record forms have been prepared, there remains the problem of putting the system to work. The necessity for having complete understanding of and agreement with the system before it is installed, by everyone who is to operate or be served by it, is of great importance. The omission of this step has blocked the effectiveness of many otherwise excellent cost systems.

Individual circumstances condition the method of making the actual installation. If the company is a small one, the cost system can probably be installed in one step. In some companies requiring very elaborate systems, the installation is, of necessity, made piecemeal. In any event, the inconvenience of change-over from the old to the new system must be reduced to a minimum so as to interfere as little as possible with established routines. Nevertheless a definite line of demarcation between the old and new systems is desirable. Where the attempt is made to introduce the new system piecemeal, the procedure is apt to be long and drawn out. The better practice in the installation of a new system is to have all forms, manuals, and instructions ready to put the new system into operation at a definite date. At the set date, the old system is cut off, records of work in process and other inventories are transferred to the new system, and operations begin. The change to the new system, whether made all at once or in sections, should follow very definite, clear-cut steps. **Journal entries** should be made, recording the transfer of values from the old to the new accounts.

As a compromise between the two methods outlined, it may be desirable to operate both the old and new systems together for a brief time in order to reduce

ACCOUNTING MANUAL

About This Manual	SECTION	1
Contents	SUBJECT	1.03
	PAGE	1 of 14
	ISSUED	1/1/__
	SUPERSEDES	

Sections of Manual

PAGE

Fig. 10. General contents of accounting manual.

ACCOUNTING MANUAL

Asset Accounts
Containers Returnable

SECTION
SUBJECT
PAGE 1 of 1
ISSUED 3/2/___
SUPERSEDES

TO: All Plants

ACCOUNT: Containers Returnable

Definition: Charge to this account the invoiced cost to us of all bags, barrels, drums, boxes, carboys, reels, cylinders, etc., which under the terms of the Purchase Order will be refunded when the containers are returned to the vendor.

Purchase Order and Receiving Department Procedure: On the Purchase Order or Purchase Shipping Order the container is to be considered as a separate item with respect to description, terms of return, price, and account symbols.

Charges to Containers Returnable: Charges to this account are made from Invoice Payable Registers.

Credits to Containers Returnable: Credits to this account are made on the basis of Stores Issues prepared in conjunction with the Special Shipping Order for the return of the container to the vendor. The Stores Issue is charged to a Standing Order for Containers Returnable to Vendors.

Debit Against Vendor: Immediately upon receipt of copy of Special Shipping Order and acknowledgment from the Shipping Department that the containers have been shipped, the Invoice Auditing Division will enter a Debit Memorandum against the Vendor on the Invoice Payable Register. The Debit Memorandum is credited to the Standing Order and entered in the Sundry column of the Invoice Payable Register. The total of all such items is to be entered as a credit to the Standing Order.

Balance of Stores Records: All transactions in connection with this account are to be recorded on Balance of Stores cards. Separate cards (by individual purchase order numbers) are to be maintained for each type and size of container received from each vendor.

Fig. 11. Typical account description in accounting procedures manual.

the inevitable confusion of the period of transition. The sudden cutting off of information to which people have become accustomed and the substitution of different information, even though that different information has been thoroughly explained and is more useful, is frequently too great a shock for some of the people the new information is intended to serve. Wherever practical, it is desirable to get into the routine of using the new information before old reports are completely discontinued.

Timing of Installation. The timing of installations of new cost and accounting systems is important. If the reports under the new system are substantially different from those previously used, or if a substantial change in the general factory or subsidiary ledgers is required, it is desirable that the new system replace the old system at the beginning of the fiscal year. This reduces the confusion incident to the installation of a new system and the complexities of the

audit and closing when two significantly different systems have been in effect during the fiscal year.

Before a new system is installed, provision should be made for getting a **comparison or reconciliation** of data for prior periods produced under the old system with future data which will result from the new system. It is neither necessary nor practical in most cases that the comparison or reconciliation be in great detail, but it is important that comparisons be sufficiently complete to permit continuity of information considered essential by people who are served by a cost accounting system.

Taking Inventory. On the date the cost system is to be installed, an inventory should be taken of all raw material. During the taking of this inventory, there should be a **cut-off** on all receipts and issues. If stores issues or receipts are unavoidable, they should be marked "before inventory" or "after inventory," as the case may be. When the inventory is completed, the balances of the various items on hand can be posted to their respective **raw material cards.** Individual items should be priced and extended to determine the actual value of materials on hand. The account in the general ledger for raw materials should be adjusted to reflect this new balance.

In making the transition from the old to the new, it is possible that accurate inventories are not available. In this event, **estimated inventories** must suffice until adjustments can be made at a subsequent date.

Control of Work in Process. If the company maintains a separate job number for each order, **job order sheets** must be set up. An inventory of goods in process is taken. The total cost, as nearly as can be determined, is charged to Work in Process in the general ledger. Individual job or **cost sheets** are charged with the costs of individual jobs in process. The total of these individual sheets should agree with the total of the general ledger Work-in-Process account. As current charges for labor and material develop they are charged to these cost sheets and to the control account. Manufacturing overhead is charged to jobs on the basis of a predetermined percentage. As jobs are completed, their cost sheets are totaled and transferred to the finished goods ledger, a proper transferring entry having been made in the general ledger.

If a **process cost system** is contemplated, it is necessary to provide for suitable process accounts and interdepartmental transfers. If a **standard cost system** is to be introduced, the method of charging and crediting Work in Process must be decided, and detailed procedures must be worked out (see section on Operation of Standard Costs).

Control of Finished Goods. Control of finished goods is next established. Finished goods on hand are inventoried and valued as accurately as possible. The total is set up in the general ledger as finished goods. **Stock cards** are prepared according to finished goods classifications, and opening balances are posted to these cards. As work in process is completed, it is transferred to the finished goods ledger.

SYSTEM REVISION. Frequently a concern finds its present cost accounting facilities satisfactory except for perhaps one or two phases. A system of **standard costs** may be desired to supplement what is already an excellent system of actual costs. In such cases, a completely new system need not be installed.

If the revision is a minor one, it can be made without a general survey of the company's operations. If the revision is to be broad in scope, however, it might be well to attack the problem as though a completely new installation were to be

made. When the proposed system is completely designed, the existing facilities which are satisfactory can be used and the old discarded.

SUPERVISION AFTER INSTALLATION. Many system installations fail because of a lack of supervision by the systems man after the system has been installed. When a new product is brought out, production "bugs" almost invariably develop; these must be ironed out before a smooth flow of production of the desired volume is achieved. In the same way unexpected difficulties frequently develop in the most carefully designed and installed cost systems. Johnson (Accounting Systems in Modern Business) points out that: "The conversion period is . . . the most hectic of all so far as the systems designer is concerned. In spite of the most careful planning, something always seems to crop up which requires attention." After the system has been in operation for a time, some changes may be found advisable in:

1. Standards.
2. Overhead rates.
3. Number and content of cost reports.
4. Procedure in handling forms.

At the end of the first annual period, the cost accountant must supervise the first closing of the books and prepare the required closing journal vouchers. When the books have been closed, the **annual statements** are made up, together with a statement on the results obtained from the first year's operations.

If an outside accountant is retained to make the **annual audit,** an opportunity is provided to make changes and improvements in the system from time to time. This is necessary because the cost system is organic and must grow and adapt itself to changing conditions. Continuous revision is essential for maximum results.

Machine Methods

IMPORTANCE AND USES OF MACHINES. As in most other fields of business activity, cost accounting and factory office routines have become mechanized. It is safe to say that modern large scale enterprises and governmental organizations could hardly be conducted without the mechanical aids now available. Certainly such equipment makes possible through reports a degree of management control which was unknown prior to the advent of the adding machine and loose-leaf records.

In a discussion of machine methods it should be recognized that there have been important technological improvements made over the years and presumably that improvement will continue in the years ahead, perhaps at an accelerated pace. Equipment manufacturers and others are carrying on research, and each year not only new models of old machines are put on the market but new machines and new procedures are developed. At any time, therefore, some of the methods described in this section may be changed or superseded by new developments. In general an effort has been made to present fundamentals rather than elaborate details because the latter are subject to rapid change.

Since about 1946 the development of **electronic data processing (EDP) equipment** has begun a new era in business control. Various reports and other vital information very helpful to informed decision making, which could not previously be economically prepared manually, mechanically, or electromechanically, are now commonplace in electronic data processing systems.

Prior to EDP, control over the enterprise was effected in a compartmentalized manner because data were collected and processed in batches and at various

locations. The task of policy coordination was extremely difficult. Electronic data processing systems, however, are not limited by departmental lines, and from the beginning it has been noted that policy coordination has become easier because information about all the various company activities is available to top management without intermediate processing at the departmental level.

Since electronic computers and the concepts of **integrated data processing** (IDP) and electronic data processing (EDP) have begun a new era in machine methods, their characteristics and functions of significance to the cost accountant are explained here.

ADVANTAGES OF MACHINE METHODS. Before the capital outlay is made for a machine system, all concerned should be aware and convinced of the several advantages advanced for such systems. National Cash Register (A Study of Machine Accounting Methods) maintains that machine systems derive their principal advantages over hand systems by virtue of:

1. The ability to protect records and funds where handling of cash is involved.
2. The ability to automatically add, subtract, compute balances, and accumulate control totals while posting.
3. The ability to post transactions on two or more related records simultaneously.
4. The ability to provide automatic and mechanically controlled features which eliminate operations and ensure greater accuracy.
5. The ability to provide mechanical proof of accuracy.
6. The ability to record a large number of routine transactions faster, more accurately, more legibly and, therefore, more economically.

The above abilities are channeled toward four **objectives:**

1. Improvement of internal control.
2. Reduction of clerical costs.
3. Improvement of the speed of data processing.
4. Injection of flexibility into the system.

In any machine system consideration of the proposed system should attain all four objectives or the majority of the objectives sufficient to outweigh those not realized.

FACTORS IN SELECTION OF MACHINE APPLICATION. Before any form of mechanization can occur, those responsible for the installation must know what is supposed to be accomplished by the operation. The job to be done is a prime factor in selecting a particular machine application. The information to be assembled includes such items as: the volume of work to be processed, whether processing of the data will be done on a centralized or decentralized basis, the types of reports needed as output from the application, what will be the source of input data, and the present flow of data in the existing operation. The result of this investigation is often a **flow chart** depicting the sequence of operations of the proposed or revised application.

After establishing the job to be done and all the pertinent facts obtained about the specific task, the next factor to be considered is, "What type of machine or group of machines can do the job?" Often the number of machines able to perform a job satisfactorily is quite large. In the case of certain involved and complex data-processing problems, however, the number of machines capable of handling the operation is small. In either situation two additional factors must be considered:

1. Comparative costs of the equipment suitable for the application.
2. The amount of personnel adjustment required by the new equipment.

Comparative Costs. The costs investigated and compared cannot be confined merely to the hardware being considered. The cost of the current operation must be compared with the complete cost of the new equipment, the caliber of **maintenance** available, accessibility to the maintenance, any change in the **grade of labor** needed for the new equipment, and the cost accompanying such grade changes.

Personnel Adjustment. A final factor which must be considered before a machine application of any kind is installed is the adjustment of all personnel affected by it. This also is a prime consideration in choosing between brands of equally suitable equipment. For example, a certain accounts receivable application was installed in which accounting machines of the window-posting type were used. Due to changes in the requirements of output data from the application, a decision was reached to use the front-feed carriage-type of multiple purpose accounting machines. Several machines were considered, but the front-feed posting machine of the manufacturer who had installed the window-posting machines was chosen. This decision was made primarily because management felt that fewer personnel problems might arise than if another brand of equipment were chosen.

It is conceivable that certain electronic computer applications or integrated data processing systems proposals would not have been considered because of the personnel adjustment necessary with this type of machine application. It should be noted, however, that while personnel adjustment is a factor which may offset small cost savings, the presence of a sizable cost savings usually means that proposals should be adopted in spite of problems of personnel adjustment.

Neuner and Neuner (Accounting Systems) discuss several principles underlying the **selection and use of mechanical appliances**:

> Basically, office appliances should be installed whenever they will reduce the actual cost of doing the accounting work, and these cost savings must be evident in the payroll. Supplementing this principle is the fact that the savings realized by the use of these mechanical devices must be sufficient to pay for the devices within a period of not more than one or two years. The third principle stresses the fact that mechanical devices should be used wherever the nature of the work is repetitive and monotonous.
>
> The fourth principle points out the fact that mechanical devices are used in accounting work because they result in more accurate work through mechanical and automatic checks. . . .
>
> Fifth in this series is the time-saving factor. Without mechanical devices much of the billing, accounts receivable, statement, and payroll work could not be completed within any reasonable length of time. . . .
>
> Finally, in the selection and use of mechanical devices the principle of standardization arises. The accounting department must of necessity standardize on certain models or types of machines because of the ease of training operators, measuring and controlling output, and reducing costs of machine service and maintenance.

MACHINE TYPES AND CHARACTERISTICS. Machines and allied office equipment used in cost accounting may be classified as:

1. Listing and adding machines.
2. Accounting machines.
3. Tabulating and statistical machines.
4. Electronic computers.

Adding machines and allied office equipment with adding machine features are classified with respect to **keyboard** structure. "Full keyboard" means that

rows of keys are provided numbered from 1 to 9. The zero prints automatically. The number of rows or banks determines the **listing capacity** of the machine. For example, eight banks handle figures up to $999,999.99. Totals may be enlarged by increasing the number of **accumulating dials.** The "ten-key" machines use only one series of keys numbered from 0 to 9. The zero key must be used on the ten-key machines. Capacity is determined by the number of accumulating dials in the register.

Machines may be classified as **mechanical or electrical.** Most makes of machines accomplish computations or sort cards by mechanical means. International Business Machines Corporation, however, manufactures machines which are not only powered by electricity but which contain sorting and tabulating mechanisms actuated by electrical contacts. Even some punching is accomplished electrically by passing a carbon mark under brushes built for the purpose. This is called **mark sensing.**

Another classification of machines is based on the **method of recording descriptive data.** When typewritten or printed words can be used, the machines are usually referred to as **alphabetic;** if such data are coded and printed as figures, the machines are called **numeric;** machines capable of handling both alphabetic and numeric data are known as **alphameric or alpha-numeric.**

Ordinary adding machines have only one set of accumulating dials. Machines with two registers are known as **duplex.** As more registers are added, the machines are referred to as **multiple register.** Most manufacturers build the registers into their machines and the number cannot be changed, but some makes have adjustable registers, and therefore the number of registers used can be changed to meet the needs of the business. The absolute limit in the number of registers is the length of the bar on which they are attached. Some machines are constructed so that the registers can be split, thereby doubling the number of totals which can be accumulated.

Listing and Adding Machines. In a broad sense all machines with accumulating registers are adding machines. Ordinarily, however, the term is confined to listing machines, i.e., machines with a tape on which the data are printed as they are added.

Accounting Machines. The term "accounting machine" is used primarily to indicate machines which will do posting work but which are not so elaborate as the statistical machines. **Multiple-register accounting machines,** however, are manufactured by a number of companies. In addition to the multiple accumulating registers for adding columns, these machines are equipped to **crossfoot,** i.e., add or subtract horizontally.

Tabulating and Statistical Machines. Tabulating and statistical machines are punched-card processing machines. The **punched-card machines** are classified by the method of sorting the cards:

1. Electrical.
2. Mechanical.
3. Hand-operated (needle).

Allied machines are needed to prepare the cards for use in the statistical machines.

In the case of the needle or **"Keysort"** process, the cards are separated and then the actual accumulation of totals in the analysis is done on an adding machine or a multiple-register machine. With the other methods the statistical work is carried forward by running the cards through a machine known as a **tabulator.**

Electronic Computers. Electronic computers may be classified according to size, which usually corresponds with price. Computers and computer systems are divided into small-scale, medium-scale, and large-scale types.

As in the case of the statistical machines, peripheral equipment is necessary to prepare data for **input** and to convert computer **output** into various accounting documents and reports. A more detailed description of electronic computers and the concept of electronic data processing is given subsequently in this section.

MACHINE FUNCTIONS. Regardless of what types of machines are used for a particular application, their function is to do the job assigned to them. Friedman (Punched Card Primer) observes that there are three basic steps involved in every accounting or statistical job regardless of whether machine or paper-and-pencil methods are used:

1. Record unit facts.
2. Classify the facts.
3. Summarize them.

Machines used in a cost accounting system must be coordinated so that these three steps are accomplished. Adding machines, for example, are primarily used in step 3; accounting machines are used to classify and summarize information; tabulating or punched-card systems and electronic data processing systems can perform the three steps without repeated transcriptions of the data and in some cases without human intervention.

ACCOUNTING MACHINE APPLICATIONS. Specific applications of accounting machines to data processing problems can be classified into four categories: (1) data origination, (2) journalizing and posting, (3) analysis, and (4) calculation.

Data Origination. The origination of data could be confined to such pieces of office equipment as **autographic registers** and **cash registers.** However, equipment used in invoice preparation, cost sheet preparation, shipping tickets, and the like should be included in this group.

Journalizing and Posting. Applications of journalizing and posting are usually classified into two groups: "back office" and "window." A **window posting** application refers to all applications in which there is a necessity to journalize or post at the time a customer initiates a transaction. Few if any cost accounting applications are of the window type, since this type of operation includes primarily:

1. Installment accounts.
2. Building and loan passbooks.
3. Bank passbooks.
4. Hotel guest accounts.

Back-office journalizing and posting applications are those which need not be done at the time a customer begins a particular transaction. The data processing is done after all the similar transaction information has been gathered and sorted so that all the stores ledger sheets, for example, may be posted in a continuous run. Such applications include:

1. Employee earnings records.
2. Stores ledgers.
3. Factory journal.
4. Factory ledger.
5. Cost sheets and many others.

Statistical Analysis. Machine applications involving the statistical analysis of cost accounting data include:

1. Materials requirement analysis by product by type of material.
2. Payroll analysis.
3. Factory overhead distribution.
4. Statistical cost accounting.

Calculation Applications. Machine applications to cost accounting operations include:

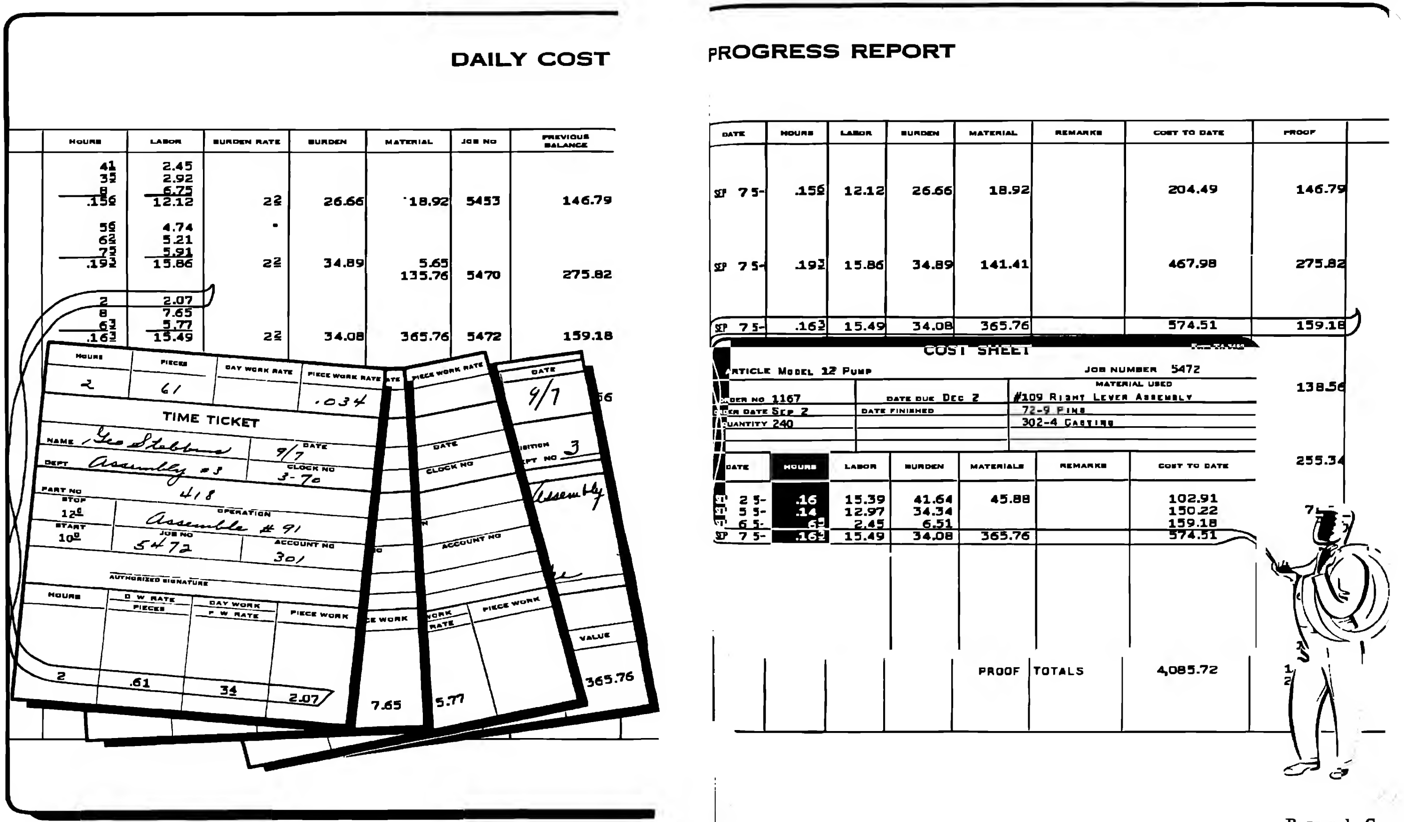
1. Payroll extension and deductions.
2. Extending materials requisitions.
3. Extending time tickets.
4. Extending and footing cost sheets.

MACHINE BY-PRODUCTS. In carrying out the routine for an application, it is frequently possible to accomplish two or more things at once by the use of an **automatic repeat mechanism** or by means of carbon. For example, a by-product of preparing a factory payroll check may be the employee's earnings ledger sheet. This can be obtained by using a machine designed to repeat the pay check figures on the ledger sheet. By using a split platen and the **repeating device,** the pay check and the ledger sheet can be prepared on one side of the carriage and the payroll journal on the other. By the use of carbon, the ledger sheet, payroll register, and the payroll check can be prepared simultaneously on certain **"front-feed" posting machines.**

Many by-product operations are possible through the use of machines with the necessary features. The following tabulation indicates some of the special **by-product results** which may be obtained in connection with the preparation of each of the major accounting records indicated:

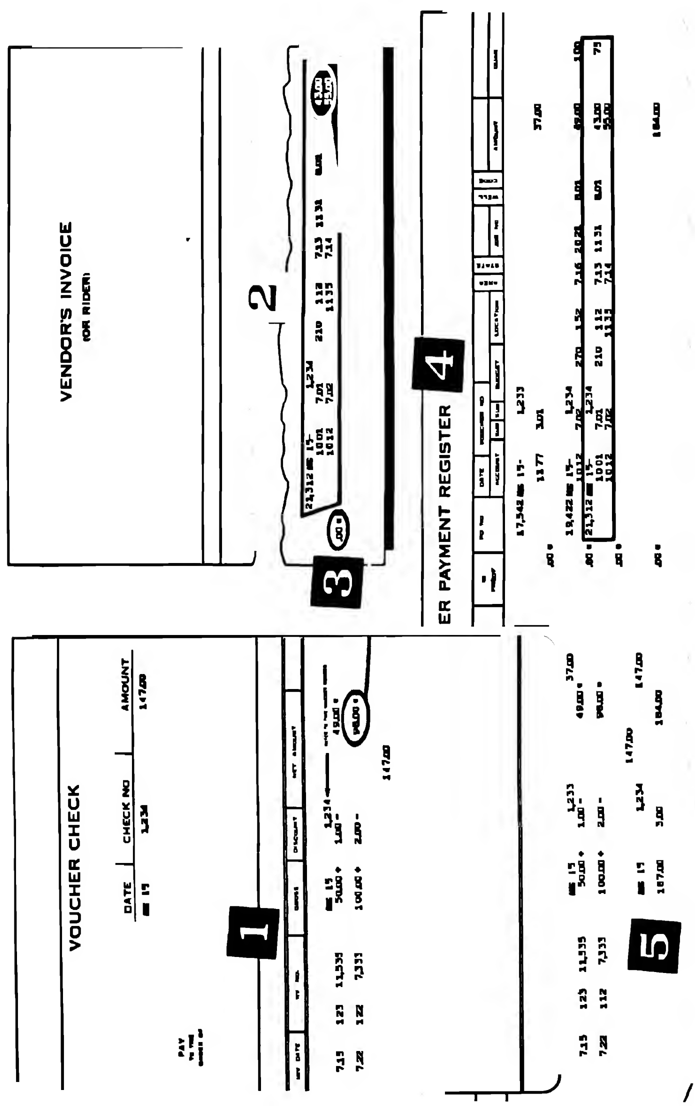
1. Accounts payable.
   a. Voucher register.
   b. Voucher.
   c. Check.
   d. Check register.
   e. Remittance advice.
2. Payroll journal.
   a. Employee's check.
   b. Employee's pay statement.
   c. Employee's earnings record.
   d. Check register.
3. Stores ledger.
   a. Materials requisition extension.
   b. Daily materials activity report.
4. Cost sheets (see Fig. 12).
   a. Time ticket extension.
   b. Overhead applications (rate × labor hours).
   c. Summary of materials requisitions.

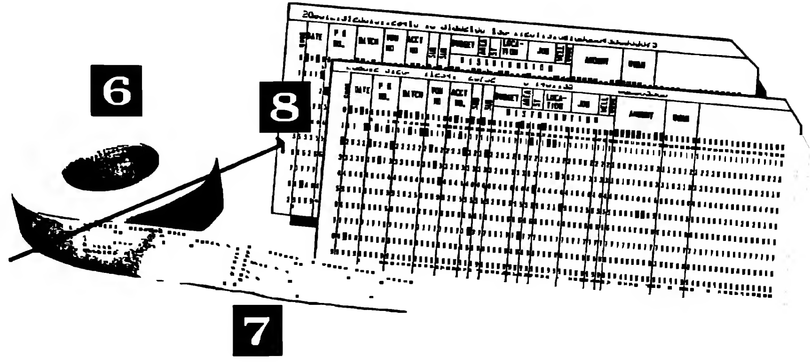
COMBINATION OF EQUIPMENT. When statistical analysis is elaborate, it is possible to make combinations of **posting equipment** with **punched tape** and/or **punched-card systems** to accomplish the desired result. Burroughs, for example, has a combination of a bookkeeping machine and a tape-punch unit. After the posting operation is completed, the punched paper tape is converted into punched cards to be used for extensive distribution analysis and other statistical analyses (see Fig. 13).



Burroughs Corp.

Fig. 12. Machine-Products of cost sheets.


VENDOR'S INVOICE
(OR RIDER)
VOUCHER CHECK
DATE
CHECK NO
AMOUNT
ER PAYMENT REGISTER
1
2
3
4
5



1 The invoice is posted to the voucher and the voucher check is computed and written
2 Coding may be machine-validated on invoice or rider
3 A zero proof of distribution is printed automatically
4 The Document Register is an automatic by-product.
5 Control totals are automatically accumulated, and printed
6 Distribution data is automatically punched into paper tape.
7 Output tape is used to prepare punched cards automatically.
8 A punched card is obtained for each distribution item of an invoice

Burroughs Corp.

Fig. 13. Use of combination of a bookkeeping machine and a tape-punch unit.

USE OF PUNCHED CARDS. The punched- or tabulating-card methods are so different from other machine methods that a separate discussion is necessary. When punched cards are used, the formal journal and ledger and the posting process are virtually omitted; accounting is reduced to **original data** and **final reports.** It is sometimes said that the card is like the pencil—it is merely the instrument by which data are transferred to reports.

BASIC PUNCHED-CARD PRINCIPLES. In manual or semi-automatic accounting systems, the three basic steps involved in any statistical or accounting work (recording, classifying, and summarizing unit facts) cannot be done without a number of **data transcriptions.** The essential element of punched-card data processing is the punched card itself. Once the source data have been transcribed to the card, there is usually no need for a second manual transcription. These data can then be classified and reclassified, and reports can be printed accordingly by machines which mechanically transcribe punched information. The speed and accuracy at which these operations can be performed permit more data to be processed by fewer people and permit analyses to be made which cannot be done economically under other methods.

PUNCHED-CARD OPERATIONS. The punched card is a unit record. All the pertinent information concerning a single transaction is transcribed from the source records to a card in the form of punched holes in predetermined positions on the card.

Card Punching. The first of three basic operations in the routine is card punching. Data to be punched may be **alphabetic** or **numeric.** Some machines can handle only numbers, and where this is the case, alphabetic data must be given a numeric code. Each kind of data is assigned to a particular group of columns, or a **field,** as it is called. The size of the field in any particular case depends on the maximum number of digits or letters needed to record the data. Punching of alphabetical or numerical data is accomplished by means of a key punch which punches a hole in one column at a time, corresponding to the key depressed. Alphabetical data are punched by a combination of two holes in one column. The alphabetical keyboard resembles an ordinary typewriter, and the numerical keyboard has ten keys corresponding to the ten numbers in a column, plus "11" and "12" keys, with punch holes for occasional special identification or classification of the card.

Card Sorting. The second operation is sorting. The sorting machine will sort the cards a column at a time according to the numbers 0–9, 11, and 12 punched in the column. The purpose of the sorting operation is to arrange the cards in sequence by some desired classification. The **sorting mechanism** of the machine is actuated by the hole in the card, either mechanically or electrically. Friedman (Punched Card Primer) points out,

> In the Remington and Samas systems, a hole is read by a mechanical "finger" tensed to reach through passing cards if it can. When a hole is found in a card at the reading station, the finger probes through it, engages the mechanism on the other side and initiates machine and/or card movements.
>
> The fingers of the IBM machines are wire brushes which rest on the cards as they flow past. When a hole comes under it, the brush reaches through and completes an electric circuit with a contact beyond the card. That electrical impulse initiates machine and/or card movements.

Tabulating. The third operation is tabulating, which is performed after the cards are arranged in the desired sequence. The cards passing through the

tabulating or accounting machine actuate various adding counters and printing mechanisms which accumulate and print reports. Alphabetical or numerical data on the cards which are merely designatory are not accumulated in adding registers but are printed on the report. Considerable **flexibility** is possible in the design of the tabulated report through adjusting (as in the case of IBM plug-boards) or inserting the proper **tabulator control panel.** Through the arrangement of wires on this panel, the tabulator is able to determine what it is to do with the data on the cards being processed and how to arrange these data on a finished report. The tabulating machine prints on a report the detail and total of the data. Connection with a **summary punching machine** makes possible the simultaneous punching of the accumulated data into summary cards. This is essentially equivalent to posting because the summary cards, when used with new data, make possible year-to-date reports.

ALLIED MACHINES. There are a number of machines allied with the key punch, sorter, tabulator, and summary punch. One of them, called the **collator,** is used to assemble series of cards which have been separated in processing; this is primarily a merging operation, but the collator can also be used for complete file maintenance operations. Another machine, known as the **interpreter,** "reads" the cards and prints its interpretation of the holes on the card. Several other allied machines whose functions are apparent from their names are:

1. Reproducing punch.
2. Card verifier.
3. Calculating punch.
4. Statistical machine (combines features of sorter accounting machine and collator).

APPLICATION OF PUNCHED-CARD SYSTEMS. Punched cards are especially well adapted to the handling of data-processing situations where certain source data are used for several residual records, analyses, and reports. For example, in **inventory and material accounting,** a balance-to-date card, receipt card, issuance card, and (in some cases) an on-order card are punched for each item of inventory. From the data punched into these cards, the following operations can be performed by the machines appropriate for the system:

1. Calculating average unit prices.
2. Pricing detail transaction cards.
3. Translating stock symbols into alphabetical descriptions.
4. Forwarding stock balances on stock status reports.
5. Accumulating activity figures.
6. Calculating the number of months' supply on hand, based on activity.
7. Preparing various inventory analyses, such as classification of inventory by class or location.
8. Preparing new balance-forward cards.

Another example is **payroll and labor accounting.** Once basic information has been punched into them, the cards can be processed for the calculation of earnings (including gross wages, deductions, and net earnings), cost charges, burden, production standards, variances, efficiency ratings, and the preparation of payroll checks, employee's earnings records, and various payroll reports. Other common applications include accounts payable, personnel and employee benefit records, and distribution accounting. Actually there are no accounting applications in which punched cards cannot be used, including general ledger reports.

Interesting developments of the punched-card method include the **dual-purpose card,** which is a tabulating card with blanks for written information. The card

is punched from the information written on it. An example of the application of this type of card is the factory **job time or piece ticket** which may be filled out in writing by the workman and then punched for sorting and tabulating. **Checks** in the form of punched cards may be punched automatically as a by-product of the tabulating operation. The checks themselves, or duplicates of them, may be used to produce tabulated reports and used also for reconciliation purposes. **Mark-sensing cards** are punched automatically by a mark-sensing machine. The graphite deposit of a pencil mark on the card closes a circuit which actuates the punch. The cards then can be sorted and tabulated like regular punched cards.

Electronic Data Processing

BASIC CONCEPTS. Processing data through punched-card machines is relatively rapid compared with other types of accounting and statistical machines. The development of the electronic computer, however, increased the potential speed of mathematical calculation and data manipulation to such an extent that punched-card systems are slow by comparison. Once data have been introduced into the computer, calculation, storage, and logical operations concerning that data can be performed at electronic speed. A type of machine has been developed which performs the equivalent of the work of several punched-card machines more quickly and without human intervention. The proper use of electronic computers makes practical the carrying out of certain analyses and the issuance of some reports to the various levels of management which previously were impossible or impractical. It also speeds up the issuance of old reports, thus increasing their usefulness.

There are two distinct types of electronic computers, called the analog computer and the digital computer. An **analog computer** represents numerical quantities by physical means such as length, degrees, etc. The familiar slide rule is an analog computer. The more complex the mathematical problem, the more complex the structure of the analog computer. For specific problems where a high degree of accuracy is not required, this type of computer is useful and relatively inexpensive to construct.

A **digital computer**, on the other hand, handles numbers as individually distinct units, and accuracy for all practical purposes is unlimited. The oriental abacus is the classical example of one of the first digital computers.

Business data processing requires that provision be made to handle a large amount of input data, compute relatively simple arithmetical calculations, and produce a quantity of output data. All these must be done with speed and accuracy. As a result of these requirements, analog computers are relatively unsuitable for use in a business data processing system. Digital computers, designed especially for this vast data-manipulation problem, are highly useful. Such systems, however, may still be kept from being efficient, in terms of the computer's capabilities, by the slowness of present input and output equipment.

SPECIAL-PURPOSE AND GENERAL-PURPOSE COMPUTERS. A special-purpose computer is a computer designed to perform one or a limited number of tasks. The Reservisor is an example of a special-purpose computer designed to handle the seat inventory or seat availability problem of the American Airlines. The command structure of such a computer is so limited that only the seat inventory problem can be solved by it.

A general-purpose computer, on the other hand, can solve various problems. Through the use of an internally stored program, a **production requirements**

planning problem can be solved by the computer. Then, by altering the program, **plant inventory** may be updated by the same machine. Because of the versatility apparent in general-purpose computers, they have been more popular for business data processing problems. Some investigators feel, however, that the day will come when special-purpose computers outnumber and process more data than general-purpose machines.

COMPONENTS OF A COMPUTER. Whether an electronic computer is analog or digital in design, it has five components:

1. Input.
2. Storage or memory.
3. Arithmetical or logical element.
4. Control unit.
5. Output.

Since analog computers are not used widely in business data processing, the following discussion of the five components of a computer will be limited to the digital type.

Input-Output. Every machine designed for mathematical calculation or data manipulation must have a way for the process data to enter the machine proper and also to be emitted when the processing is finished. Punched cards serve as an input medium in a punched-card data processing system. In an electronic system the three most common media for introducing data into the system are **punched cards, magnetic tape,** and **punched-paper tape.** It is possible in most systems to communicate with the central processing unit of the system directly through the control console or electric typewriter connected to the control unit, but these media are primarily for exceptional, not for regular, data introduction. Both punched cards and punched-paper tape are slow inputs when compared with magnetic tape. An IBM Type 650 computer system can read 80-column punched cards at a rate of 200 cards per minute, or approximately 265 characters per second. (Each column on the punched card represents 1 character.) On the same Type 650 system, magnetic tape can be read into the machine at the rate of 15,000 characters per second. Punched-paper tape is somewhat slower than magnetic tape but is faster than punched cards.

Output is comparable to input. The data processed can be punched into cards or paper tape or placed on magnetic tape, but it is also possible to print the results through an on-line, high-speed printer capable of printing 120 characters per line at rates in excess of 600 lines per minute. The **control console** and **electric typewriter** may also be utilized for output on an exception basis.

Choice of Input-Output Method. It is not possible to develop a universal rule that can be invoked when choosing input-output equipment. Each installation is unique, and each type of input-output media has certain advantages. Where it is required that the computer work at its maximum speed, however, magnetic tape at present is the most logical input-output medium because it has the most rapid processing rate. For applications in which speed is not "of the essence," punched cards or paper tape may be appropriate input-output media.

Central Processing Unit. Two of the computer components, the **storage** or **memory** and the **arithmetical** and **logical** unit, are housed in the central processing unit. The storage located inside the central processing unit is called **internal storage.** Electronic data processing systems utilize **external storage** in the form of reels of tape or stacks of cards when the internal storage is not large enough to store all business data necessary to be retained.

Internal storage, however, is the place in the computer where data is stored so that it will be available at electronic speeds for various calculations. An example of what may be stored in the internal storage section of a computer would be costs to date on unfinished jobs which are up-dated as the current cost tape is read into the computer. There are several types of internal storage, and the type that is used in a particular model depends entirely on the job needed to be done in each instance.

Magnetic drum and **magnetic disc storage** seem to be most popular with medium-scale computer systems, while magnetic cores seem to be used most in the large-scale systems. Haskins & Sells (Data Processing by Electronics) point out:

> The over-all speed of the central processing unit in the electronic system is largely dependent upon the speed of access to data and instructions in storage. Information stored in magnetic cores . . . remains in a static state. Access to the bits of information is direct, and hence inherent speed of access is greatest. Information in . . . magnetic drums moves or circulates within the storage device. Inherent speed of access is slower, since access is gained by picking off the information at a fixed point in the cycle of movement.

Once data and instructions are stored in the central processing unit, additional data must be fed into the **arithmetical or logical unit**, where either a mathematical computation is performed concerning the new data and data is brought from storage, or a logical choice is performed between two items of information. For example, in processing the monthly payroll, it is possible for the computer to test for tax limitations before calculating the amount to be withheld. A second example would be inventory control. After adjusting inventory balances for daily receipts and withdrawals, the computer will compare the resulting balances with predetermined minimums. It will pass those items still over the minimum but will print out or prepare a magnetic output tape of all items which are under the minimum and therefore should be reordered. It is this capacity to perform **logical choices**, even though simple, that enables an electronic computer to follow a long sequence of predetermined operations without human intervention.

Control Unit. The control unit is the most complex component of an electronic computer. This unit controls the operation of the central processing unit and the pieces of peripheral hardware connected to the system. Through its instruction register, timing and execution circuits, and instruction counter, this unit executes the **internally stored program** in its proper sequence. The console of the control unit permits the machine operator to check the status of the problem through the bank of lights whose "on" or "off" state is comparable to the state of the circuitry inside the processing unit. A keyboard is present in some fashion on the console which permits the operator to change the stored program manually or insert small amounts of new data into storage. An electric typewriter is also connected to the console to permit selective or exception information to be typed out immediately upon detection.

COMPUTER OPERATION. In order for a general-purpose digital computer to operate on selected input data, a detailed **program of instructions** must be prepared so that the input data can be processed properly. Because a computer does not have an intellect, it is impossible for it to process data in any kind of orderly fashion unless the data processing operation can be reduced to a set of logical instruction steps. For example, if the gross wage of an employee

for one week was supposed to be calculated by a computer, the instructions for this task would be similar to the following:

1. Read the employee number, hours worked, and rate per hour into the internal memory of the computer.
2. Transfer the employee number, hours worked, and rate per hour to an output punching area of computer memory.
3. Multiply the hours worked by the rate per hour.
4. Transfer the answer to the output punching area.
5. Punch a card containing employee number, hours worked, rate per hour, and gross wages.

The individual **command structures** of commercially available computers vary considerably. Regardless of how extensive the command structure of any computer may be, all are confined to approximately nine **basic operations**:

1. Add.
2. Subtract.
3. Multiply.
4. Divide.
5. Read data from an input unit into internal storage.
6. Write data from internal storage on the output medium.
7. Compare two numbers to determine equality or which of the two is larger or smaller in magnitude than the other.
8. Transfer data from one part of the internal storage to another.
9. Scale data by shifting right or left *n* places while this data is in an arithmetical register.

It is the job of the person responsible for program preparation to see to it that the commands available can be arranged, combined, or coordinated so that a particular amount of data can be processed satisfactorily.

Program Preparation. The importance of program preparation is expressed by Githens and Van Gorder (Proceedings of the Nineteenth Annual Institute on Accounting, The Ohio State University) as follows:

> One of the dominant characteristics of computers is that they will treat only data which is 100 percent properly prepared, and process only problems for which they have been programmed. A single misplaced digit, a missing digit, or an excessive digit all have the same effect. The computer stops and the giant, which is capable of calculating several thousand multiplications per minute, stupidly blinks its electronic tubes at the operator. The insertion of a data problem condition for which no program loop has been built into the routine has an identical effect.

Program preparation, however, with the degree of perfection needed, is not a simple operation. It consists basically of three phases: (1) systems analysis, (2) programming, and (3) coding.

Systems Analysis. The investigative phase in which the present data processing system is studied thoroughly to determine what is being done is known as systems analysis. Very often this phase is begun during the **feasibility study period** prior to the decision to install an electronic computer.

Based on his analysis of the present system, the electronic systems analyst must redesign the system in terms suitable for use with an automatic electronic computer. Chapin (An Introduction to Automatic Computers) points out that the systems analyst must:

1. Determine precisely what will constitute acceptable output from the automatic computer.

2. Determine the nature and form of the information that can be made available for use as automatic computer input.
3. Determine by logical analysis the logical relationships between the input and the output.

Programming. The solution usually prepared by the systems analyst is in the form of a series of **flow charts** in which the steps needed in the data processing problem from input source to output are presented graphically. The computer programmer prepares **block diagrams** from the flow charts in which a more detailed graphical analysis defines the logical operations necessary to solve the problem on a particular computer.

Coding. This is the translation of the detailed block-diagrammed steps of a problem into the command language of the computer used in the installation If the systems analysis and programming phases have been completed properly, the coding of the program is not difficult. Very often, however, due to incomplete programming, the coding operation is a combination of programming and coding.

FEASIBILITY STUDY. Before the question of the feasibility of installing an electronic data processing system can be answered, a thorough and detailed analysis (as described under Survey of Cost Accounting System in this section) must be made of the existing data-processing system in order to provide a factual foundation for projecting possible electronic computer applications and to indicate the scale of computer needed for the system. The cost of this analysis alone demands a decision as to whether it will be to the advantage of the company to study the feasibility of the installation of an EDP system. Some idea must be obtained as to the cost of inefficient operations under the existing system, which would be eliminated or drastically cut in an electronic system, or a need must exist for more management control information than it is possible to develop under the present system.

Once a decision has been reached that a feasibility study should be made, an investigative team should be appointed and given the responsibility for undertaking the task. Who should be selected for this team? Wallace (Appraising the Economics of Electronic Computers) states that:

> Usually the computer team should be made up for the most part of men who know the company and its operations. Their backgrounds might be tabulating, procedures work, accounting system development, or industrial engineering. Many men with scientific backgrounds such as mathematics or physics have entered the computer field. Such men can make an excellent contribution to the computer team. However, the majority of the team should be composed of men who know business procedures and, if possible, the company, its people, and its atmosphere.

The feasibility study group will be expected to select specific data processing areas for study, conduct a **preliminary procedure analysis,** present various statistics comparing various types of equipment and cost of acquisition, and present the limitations as well as the expected accomplishments of a computer system. While the task is arduous and unique, a time limit of some kind, depending on the size of the company, should be placed on the study group for the submission of their final report so that undue procrastination will be avoided.

In order to do the preliminary work of a feasibility study, the study itself, the installation of the EDP system, and the operation of the system, certain levels of proficiency must be achieved by the members of the firm responsible for any of these phases. Fig. 14 correlates the basic skills needed for a complete EDP

	Total	Broad Picture of Management Problems	Knowledge of Specific Company Policies and Procedures	Mathematical Know-How	Training and Experience in Punched Card Equipment	Scheduling and Planning Work Loads	Computer Training, Programming	Computer Training, Operation of Equipment
Top Management.	14	10	2	1	0	0	1	0
Advisory Committee	22	9	5	1	2	2	3	0
Feasibility Group	39	8	8	1	8	5	7	2
Installation Group	55	5	10	2	10	10	10	8
Data-processing Center	43	2	2	1	10	10	8	10
Forward-planning Group	39	8	8	1	8	5	7	2

Peat, Marwick, Mitchell & Co.

Each management group rated from 0–10 according to competence needed in each skill.

Fig. 14. Basic skills needed by groups for complete electronic data processing installation in a company.

installation and the various teams within a company which are responsible for the system.

Areas for Study. The areas to be studied can be chosen by the feasibility team if three factors are considered carefully. Wallace (Appraising the Economics of Electronic Computers) holds that, ". . . the higher the annual clerical costs involved in an area (procedural area), the more attractive it is for inclusion in our initial study." He maintains that two other factors play an important role in selecting areas for study:

1. The more simple it would be to apply a computer to a given area, the more attractive that area is for initial study. The reason for this is that the programming and installation steps are difficult and time consuming at best in the first applications. Therefore it is more desirable to start with the simpler applications and work up to the more difficult ones.
2. The greater the potential for intangible benefits in a given area, the more attractive this area is for an initial study. Here the reason is obvious. It means that we can obtain benefits over and above clerical cost reduction Among such benefits may be lower inventories or better management controls information.

Analyzing Procedures. According to Haskins & Sells (Data Processing by Electronics):

Analysis is nothing more than ascertaining, step by step, how something is now done, followed by determining, also step by step, how it may otherwise be done. The question of need enters also into the matter. Analysis may reveal that data for which need no longer exists continue to be compiled or, conversely, that data which may be highly significant have never been developed. Flow charts, data on work loads and time schedules, and manuals or memoranda of procedures are among the useful aids of analysis.

In the feasibility study stage, the analysis of present procedures and the improvement thereof is of a much more detailed nature than the flow charting and planning of the proposed electronic data processing system. The latter is of prime importance during the installation phase. Wallace (Appraising the Economics of Electronic Computers) points out:

The experience of some companies who have made feasibility studies indicates that the procedural improvements and resulting cost savings derived from this step more than pay for the study even if the eventual decision is against acquiring a computer

After improving the present system as much as possible, the question, "Can an electronic data processing system improve our information system further?" may be investigated.

Kind of Equipment. Once it is evident that an electronic data processing system will process necessary data more effectively and efficiently than the present system, the decision must be made as to what kind of equipment to use and whether it can be installed economically. A number of factors must be considered.

1. What are the prime management objectives that this system must serve?
2. In view of the management objectives, what scale of computer system will best aid in attaining the objectives?
3. What will be the cost of installation, conversion, and maintenance of the proposed system?
4. What cost saving will result, if any?
5. What will be the benefits other than cost saving in operating the data processing system?

One of the most important of the above factors is choosing the **proper scale computer.** What are the means of identifying the suitable electronic computer? Chapin (An Introduction to Automatic Computers) states that the elimination problem has several steps:

1. Determine the storage requirements.
2. For those automatic computers that meet minimum storage capacity requirements, make an evaluation for each of the tentative applications in terms of input-output requirements.
3. Evaluate the still remaining automatic computers in terms of their speed.
4. Evaluate the remaining automatic computers in terms of their variety of commands.

Once such factors as the storage requirement, speed, and need for variety of commands have been determined, the scale of computer necessary for an efficient system can also be determined. It is then possible to make reasonably reliable **cost comparisons** between the existing system and an electronic system. In Fig. 15 Wallace (Appraising the Economics of Electronic Computers) shows the approximate annual costs of medium and large computer systems. Because of the rapid technological changes in computer design, the specific amounts in Fig. 15 may change. This table is shown primarily to illustrate the relative difference in cost between medium- and large-scale computers. In making cost comparisons between old and new systems, the observation of Seney (NAA Bulletin vol. 50) should be kept in mind: "When records are kept and analyses are performed with the help of punched-card or electronic installations, clerical costs tend to become more fixed and less variable. . . ."

Immediate and Potential Applications. It has been said that a computer system should replace a number of office clerks. A reasonable axiom to follow in these considerations has been stated by Haskins & Sells (Data Processing by Electronics):

> In the light of the job to be done, including not only immediate application but potential application of major significance as well, the factor that should govern the selection of equipment is economic balance. The combination of equipment within the system should be designed to produce the maximum economic benefit within the limits of the choices available. The ideal combination, of course, would be the smallest number of units of each component, all operating with a minimum of interruption. But here, as in other phases of business operations, the ideal will seldom be attained. The problem is essentially one of leveling out variations in work loads in so far as planning and characteristics of the equipment will permit.

APPLICATION TO WEEKLY PAYROLL. A typical example of an accounting application of electronic data processing is the processing of a weekly payroll, as explained by Haskins & Sells (Data Processing by Electronics). The components of such a system would consist of a processing unit, a number of units for both reading and writing tapes, a high-speed line printer, and key-driven paper-tape punches and a paper-to-magnetic tape converter as input preparation equipment.

The **payroll procedures** must be completely analyzed, and the routine required to compute gross pay and deductions and to distribute payroll charges must be programmed and coded into instructions, which are key-punched on magnetic tape. The **master personnel files** containing carry-forward payroll and personnel data are also punched on magnetic tape. Haskins & Sells illustrate the payroll application, under these assumed conditions, in the diagram shown in

TYPICAL ELECTRONIC COMPUTER ANNUAL OPERATING COSTS
(In thousands of dollars)

Type of Cost	Medium-scale Computer						Large-scale Computer					
	One-shift Operation		Two-shift Operation		Three-shift Operation		One-shift Operation		Two-shift Operation		Three-shift Operation	
	Rental	Purchase	Rental	Purchase	Rental	Purchase	Rental	Purchase	Rental	Purchase	Rental	Purchase
Preparatory and conversion costs (five-year amortization):												
Computer site preparation:												
Medium-scale — $15,000	$ 3	$ 3	$ 3	$ 3	$ 3	$ 3	$ —	$ —	$ —	$ —	$ —	$ —
Large-scale —$150,000	—	—	—	—	—	—	30	30	30	30	30	30
Program preparation and data conversion costs:												
Medium-scale — $55,000	11	11	11	11	11	11	—	—	—	—	—	—
Large-scale —$350,000	—	—	—	—	—	—	70	70	70	70	70	70
Equipment costs:												
Rental	96	—	144	—	192	—	360	—	540	—	720	—
Amortization of purchase price—five-year basis:												
Medium-scale cost — $250,000	—	50	—	50	—	50	—	—	—	—	—	—
Large-scale cost —$1,250,000	—	—	—	—	—	—	—	250	—	250	—	250
Interest on investment (4%)	—	10	—	10	—	10	—	50	—	50	—	50
Equipment maintenance — supplied by manufacturer under rental—under purchase assuming contract with manufacturer	—	58	—	74	—	91	—	90	—	125	—	175
Personnel costs												
Programming and computer operation	40	40	44	44	49	49	79	79	98	98	118	118
Physical and data media costs:												
Space rental, power, supplies, etc.	8	8	8	8	8	8	30	30	30	30	30	30
Total annual costs (five-year amortization of purchased equipment)	$158	$180	$210	$200	$263	$222	$569	$599	$768	$653	$968	$723
Revised annual costs based on ten-year amortization of purchased equipment	$158	$155	$210	$175	$263	$197	$569	$474	$768	$528	$968	$598

Fig. 15. Typical computer cost comparison.

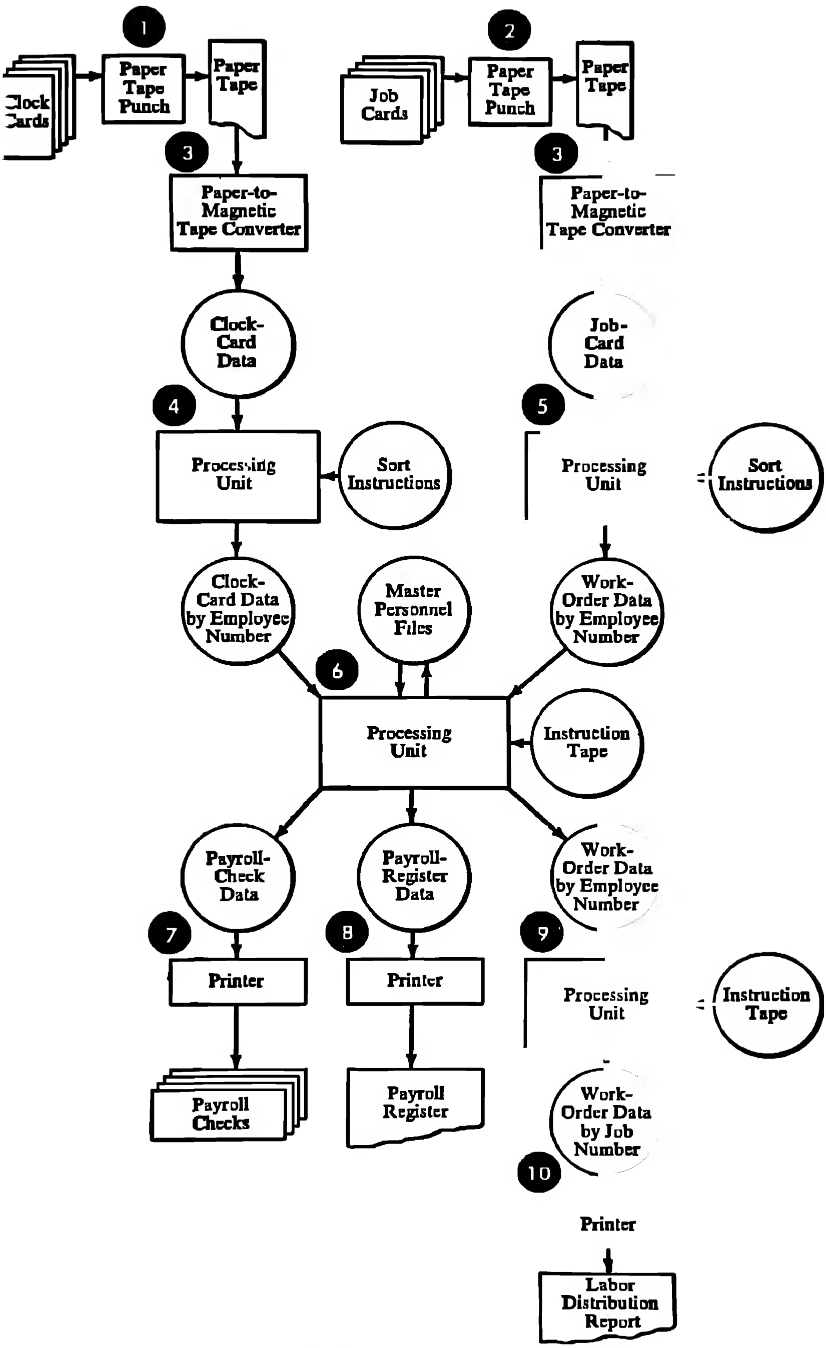


Fig. 16. Steps in payroll processing routine.

Fig. 16, which denotes by number references the following successive **steps in the processing routine:**

1. At the end of each payroll period, key-punch operators punch from the clock cards a paper tape showing employee number and total hours worked for each employee.

2. Key-punch operators also punch from job tickets a paper tape showing employee number, work order number, and time spent during the week on each job.

3. The paper tapes prepared in steps 1 and 2 are converted to magnetic tape on paper-to-magnetic tape converters.

4. A sorting operation is next performed. As the first step, the following reels are placed on the tape read-write units:

a. The reel containing the coded instructions for sorting data from the clock cards into employee number sequence.
b. The reel containing the clock-card data on the tapes prepared in steps 1 and 3.
c. The reel to receive the clock-card data sorted in employee number sequence.
d. Two or more reels to store partially sorted data temporarily.

To start processing, the coded instructions from reel (a) are read into storage, and the clock-card data from reel (b) are read into storage and processed in accordance with the coded instructions. Following this, the clock-card data, now sorted in employee number sequence, are written out on the magnetic tape, reel (c).

Sorting having been completed, the reel containing the sorted clock-card data is removed and held for processing in step 6 The reel containing the sorting instructions is removed and held for use in connection with the next week's payroll, and the reel containing the unsorted clock-card data is removed and held temporarily for reference.

5. A similar sorting operation is performed upon the job-tickets data placed on magnetic tape in steps 2 and 3, to arrange the data in employee number sequence.

6. The following reels are placed on the read-write units:

a. The reel containing the coded instructions for processing the payroll checks, payroll register, and labor distribution.
b. The reel containing the master personnel files.
c. The reel containing clock-card data in employee number sequence, prepared in step 4.
d. The reel containing the work-order data from job tickets, in employee number sequence, prepared in step 5.
e. Reels of tape to receive the payroll-check data, the payroll-register data, and work-order data.

The tapes upon all reels (a) to (d), in the programmed time and order sequences, are read into the processing unit, and after being data-processed there, the following tapes are prepared on the read-write tape units:

a. A tape containing all data required to prepare payroll checks.
b. A tape containing all data required to prepare the payroll register.
c. A tape containing work-order data (in employee number sequence) to be used in processing the labor distribution record. At this point the work-order data have been balanced with the hours from the clock cards and have been extended in dollars, using the employees' wage rates.

Following this, all the reels are removed from the read-write units. The reels containing the coded instructions and the master personnel files are held for use

in connection with the next week's payroll. The reels containing the data required to prepare pay checks, the payroll register, and the labor distribution are held for processing in steps 7, 8, and 9 respectively. The reels containing the clock-card data in employee number sequence and the work-order data in similar order are held temporarily for reference.

7. The reel containing the data required to prepare the payroll checks is connected to the printer, and the payroll checks are prepared automatically.

8. The reel containing the payroll-register data is connected to the printer, and a payroll register is prepared, again automatically.

9. The reel containing the work-order data in employee number sequence is next processed to produce the data required for the labor distribution report.

To avoid repetition in the explanation and also to illustrate a difference in processing methods, it is assumed that the number of job orders involved is limited, and therefore it is unnecessary to perform a sorting operation to produce the required data. The following reels are placed in the read-write units:

a. The reel containing the coded instructions for processing the labor distribution.
b. The reel containing the work-order data (prepared in step 6).
c. A reel to receive the processed data.

The tapes upon the first two reels, in the programmed time and order sequence, are read into the processing unit, and after the data are processed there, a tape containing the total labor charged to each job, in job-order sequence, is prepared on the read-write tape units. In this case arrangement in sequence was accomplished in processing by assigning addresses in sequence to the respective job orders.

The reels are then removed. The instruction tape is held for use in processing the next week's labor distribution records. The reel containing the work-order data in employee number sequence is held temporarily for reference. The reel containing the work-order data in job-order sequence is used in step 10.

10. The reel containing the work-order data in job-order sequence is connected to the printer, and a labor distribution report is prepared.

As Haskins & Sells emphasize, the required procedures for this application are merely outlined in a general way, omitting many details such as the content and explanation of programs.

LIMITATIONS. Daniel (Controller, vol. 26) reports that a number of businessmen are concerned over the failure of their electronic data processing systems to produce the anticipated advantages. He discusses the following as the six key barriers which a company must overcome if the computer system is to be successful:

1. The failure to establish genuine top-management interest and support of electronic data processing as a concept instead of fascinating hardware.
2. The inability to achieve an effective blend of existing company personnel with "outside" talent.
3. The absence of a realistic and workable relationship with the manufacturer of the electronic data processing equipment selected.
4. The failure to recognize and promptly act on the organizational implications of electronic data processing.
5. The inability to effect the behavior changes required to realize many of the potential advantages of electronic data processing.
6. The failure to anticipate the "disillusionment" that frequently develops.

The inherent limitations of an electronic computer and the resultant electronic data processing system have been largely ignored in most discussions of the

subject. In addition to the barriers listed above, it should be recognized that there are some operations for which these machines are not suitable.

Fairbanks (Successful Office Automation) states that a computer is limited because it offers only:

The opportunity to relieve human beings of mechanical repetitive tasks to a greater degree than any previous machines have.

The possibility of performing these repetitive tasks faster than human beings can perform theirs.

Because of their tremendous speed, the possibility of performing functions that require so many thousands of calculations that they cannot be performed practically by any less speedy means.

The elimination of the physical movement of data from one processing step to the next, as self-contained units capable of performing a chain of sequential actions within themselves.

Frequently computer systems are hampered because they are asked to do things which they were not made to do. **Sorting,** for example, is done extremely inefficiently by a computer. An operation with many **exceptions** to be programmed is also inefficient. Nor can a computer paint a fence or change a tire. It is limited to the processing of information and can do this only if a logical command sequence has been prepared in advance for it to follow.

Because of the need to be instructed to do each logical step, computer installations also fail or are hampered severely because of insufficient preliminary work. Lewis (Harvard Business Review, vol. 35) states:

The proven route to success in applying a computer to business data processing problems is the complete analysis of what is wanted from the computer and how it can be obtained in detail before accepting delivery. This means many more years of preliminary investigation, detailed programming, testing, and reprogramming.

Lewis also points out that the decision whether or not to install a computer need not be a unique decision but that:

The decision on a computer installation is just another business problem. It must be shed of the tinsel which now envelops it. Decisions should be made in the same way business decides to add a new product line or to build a new plant. The crucial question for management is very simple: Will this move add to the company's profits?

Management should not be "fast-talked" into a decision to install a computer. Their investigation must be critical and impartial, and above all, it must be thorough.

ELECTRONIC DATA PROCESSING MANAGEMENT PROBLEMS. Three challenging problems are normally encountered by management during the feasibility study and in carrying over until the new electronic data processing system is firmly entrenched and operating with relative efficiency: (1) organizational and structural upheaval takes place, (2) personnel adjustment is necessitated by the electronic system, and (3) the actual conversion must be made from the present system to the electronic system.

Organizational Changes. Concerning organizational consequences, Chapin (An Introduction to Automatic Computers) states:

Automatic computers have two types of organizational consequences: (1) self-imposed consequences brought about primarily by organizational units while preparing the new systems that are to be used with the automatic computer; and (2)

organizational consequences that result from the actual use of the automatic computer.

Chapin maintains in addition that because of the extent of the investigation and system analyses that must be made in order to investigate the possibility of acquiring a computer system and then installing it, many organizational lines are crossed, conflicts of interests arise and must be solved, and "bold thinking must be done." The ultimate results are changes in goals, methods, and interests.

Chapin points out that a new organizational unit normally emerges during a computer installation, possibly called the **computer development section,** whose "function involves coordinating changes, and selling changes in systems to many organizational units." These are "self-imposed consequences."

Effects on Personnel. The second type of consequence is more in the nature of organizational changes caused because the computer is not only now performing certain functions that people need no longer perform, but also that the remaining organizational units are performing their functions differently than before and may well need to be reorganized. Chapin (An Introduction to Automatic Computers) states:

In grouping the new sets of functions during the reorganization, an effort should be made to eliminate old empire building, to thwart the building of new empires (including those built on any "mumbo-jumbo" involving the automatic computer!) and to simplify and streamline the organizational structure. That means simplifying and clarifying the loops of control, so that company objectives can be realized as easily as possible.

The position of the **processing center** itself in the revised organizational framework of a company using electronic data processing has a definite effect on the solution to the organizational problems outlined here. No definite axiom can be developed because this is a company problem. Whatever the solution, however, for an individual company, the solutions of additional organizational problems must be related to this decision. Wallace (Appraising the Economics of Electronic Computers) states:

Many companies consider that the computer center falls properly within the scope of the controller or other financial officer. This opinion is based on the fact that most initial applications concern financial activities and, in addition, there usually already exists a concentration of data and data processing under this officer. There are companies, however, which may convert nonfinancial activities to the computer or which look upon an electronic data-processing center as having a companywide potential too broad to restrict it to any one service department. Consequently these companies may organize the computer center so that it reports to an executive who is independent of all existing operating and service departments.

Computer Management. The individual in charge of this new unit of management's team is given some specific but far reaching duties by Hollander. He states (NAA Bulletin, vol. 38) that regardless of his title (which might be administrative vice president) some of his responsibilities, among others, will include the following:

1. Administration, but not creation, of over-all company policies, particularly in those areas where line responsibilities cross or conflict. In such a capacity, it is possible to relieve the top senior officer of the time-consuming and unrewarding necessity of resolving internal strife.

2. Evaluation of significant system changes in the light of their effect on profit making potential. Because of lack of line responsibilities in this area, it is possible to arrive at clinically detached conclusions.

3. Over-all direct responsibility for maximum integration of all data processing. This includes the selection of logical areas for automation of off-line data generation. Examples are (a) order origination, (b) time ticket and materials requisition preparation, (c) shipping document preparation, (d) purchase order initiation, (e) receiving report preparation, and (f) revenue and disbursement control.

4. Direct line responsibility for the operation of the central computing center (or centers), internal staff training, quantity, quality, and time phasing of all required data output.

5. Provision of staff assistance to line officers in the administration of their assigned responsibilities. In this relation, a much needed service can be performed in the predominant area of intra-department, as opposed to total system, data processing requirements.

Human Relations and Training. Personnel maladjustment cannot help but be a direct result of the organizational upheaval previously described. Personnel readjustment, therefore, must be tactfully and thoroughly effected. Fear of the unknown effect of the proposed data processing "giant" on their present jobs and their importance, fear of their own ability to adjust to a thoroughly new situation, and fear of their ability to handle the added responsibility that may result must be removed. Chapin (An Introduction to Automatic Computers) lists principles of human relations that should be followed to keep political maneuvering from hampering or even preventing the installation of an automatic computer:

1. Arrange things so that people feel important.
2. Arrange things so that people are "in the know."
3. Arrange things so that people can win over obstacles together.
4. Avoid jeopardizing a person's social status.
5. Recognize the importance of a person's off-the-job life.
6. Couple a person's personal objectives to the company's objectives by means of the economy of incentives.
7. Respect each person as an individual.

In addition to adhering to the foregoing human relation principles, proper training must be given to the employees who will be directly or indirectly concerned with the computer unit. This training, besides including **technical operational instruction,** must also include **relocation or new job training** for the employees transferred to positions in other departments. It must also provide reorientation training for employees who are not being transferred but whose former jobs now have different functions due to the installation of a computer. (Also see Human Reactions to Standards and Controls in the section on Cost Control, Budgets, and Reports.)

Conversion Period. Conversion of the present data processing system to an electronic system centered around an automatic computer cannot actually begin until the organizational realignment and personnel acceptance problems are near solution. According to Canning (Installing Electronic Data Processing Systems) typical problems during the conversion period ". . . include breaking down the over-all job so that smaller portions can be converted, converting manual files to machine language, establishing mechanization of the input information, consolidating files, cleaning up the errors that are detected during consolidation, and testing the program prior to operation." Canning also points out that, "It is hard to generalize very much about methods for performing conversion efficiently, since the methods are so often determined by the specific application." There-

fore the decision of whether to convert abruptly, i.e., stop the semi-automatic data processing system today and start the electronic data processing system tomorrow, or to convert the system gradually by operating both systems in parallel until conversion is completed, depends on individual circumstances.

INTEGRATED DATA PROCESSING. As punched-card and electronic data processing systems were refined and used by a large number of companies to process business data, one of the most frustrating problems confronting the processors of business data could be reduced to a reasonable solution. Data processing systems involving conventional bookkeeping or accounting machines required that data to be processed must be introduced into the machines manually, with the corresponding chance for error each time a second step in the system was to be taken. For example, after voucher checks have been prepared on a front-feed conventional accounting machine, unit distribution stubs prepared from each voucher must be sorted by expense classification, each classification totaled and then reintroduced manually into the machine in order for a proper posting to be made to the various expense classifications. As a result of several manual introductions of data into and transcriptions within a system, the accuracy, while good, is not good enough nor is its recording rapid enough to handle efficiently the mountain of paper work in a modern industrial or business enterprise. According to Johnson (Accounting Systems in Modern Business):

> It follows, then, that in an integrated system one of two things should occur as early in the cycle as possible: (1) all copies of data to be used throughout the entire business organization should be duplicated by carbon or by other means, or (2) provision should be made to produce automatically the desired copies of the data as required later in the cycle. By either of these approaches, data are written by human effort only once (at the point of entry into the cycle), are verified once at that point, and thereafter proceed speedily throughout the system without costly, error-prone human labor and without the need for repeated verification.

Centralization of Operations. The development of punched cards, punched-paper tape, and magnetic tape as workable common language media permits data processing operations to be centralized. **Common language** means that the tapes, cards, and other computer media are expressed in a code system compatible with the data transmission equipment and other data processing systems. There is no clear-cut need any longer for a separate accounts payable machine application, or cost distribution or inventory control with a machine installation, to match each data processing routine. It is now possible, for example, to use punched cards, punched-paper tape, or magnetic tape prepared from vendors' invoices to make up the voucher check, post to subsidiary inventory records, up-date controls, and adjust budgeted control figures in a series of operations without manually introducing any additional information into the system or without manually transferring data within the system. This development led to the concept of integrated data processing.

Characteristics of Integrated Data Processing. The concept of integrated data processing was formalized in the American Management Association Special Report No. 11 which states:

> Integrated data processing is the effective production, through the systematic organization of all related clerical routines, of a coordinated and uninterrupted flow of essential data (information) needed by management in its decision-making, control, and planning functions. . . . IDP, in other words, becomes a concept which integrates communications; mechanical, electrical, or electronic processing or computation; and control of business data.

AMA Special Report No. 11 points out further that there are three points of fundamental difference between this IDP approach and the traditional methods of data processing which must be distinguished:

1. Original data are recorded in a mechanical form at their point of origin. In other words, all pertinent information is recorded once at the beginning of the clerical process.
2. From then on—whether on tape, cards, film, or whatever the medium may be—data are processed exclusively in a mechanical manner. The whole concept of IDP is negated if at some station along the line data are again recorded manually.
3. All processing of data is integrated so that original data in mechanical form serve all subsequent applications.

Effects on Decision-Making. An important result of the development of the "integration" concept was its effect on management's decision-making. Whether management was aware of it or not, compartmentalized data processing tended to nurture compartmentalized business decisions. Under an integrated data processing system, management is able to embrace a new concept of management. Bradshaw (Proceedings—Automatic Data Processing Conference) contends that:

> This new concept of management consists of three parts. The first is setting up company and departmental goals and the necessary controls to insure flexibility in planning and in the attaining of these goals. The second is organizing so as to spread the proper motive throughout the company organization. And the third is building an organization that can help the chief executive carry out his job of coordinating the parts and that also can supply him with the tools of planning and control.

Integrated data processing is capable of giving management more implements to control the whole enterprise than were ever thought economical or even possible a few years ago.

SECTION 4

COST ACCOUNTING DEPARTMENT

CONTENTS

SECTION 4

COST ACCOUNTING DEPARTMENT

Objectives and Requirements

GENERAL OBJECTIVES. The objectives of the cost accounting department in a modern business enterprise are:

1. To compile the cost data required to meet legal and corporate requirements.
2. To provide and interpret information relating to the cost of production and distribution of the products or services for the purpose of assisting management in the direction and control of the business.
3. To perform these functions in an intelligent and economical manner, making a maximum contribution to the profitability of the operation.

LEGAL AND CORPORATE REQUIREMENTS. The legal and corporate requirements are the mandatory or inescapable part of the job. The cost accounting department in this capacity is contributing to the general and tax accounting requirements of the business through the compilation of cost data and the making of necessary allocations of costs to:

1. Determine total company profit and year-end inventory figures for preparation of income tax returns, for reports to shareowners, and for the Securities and Exchange Commission.
2. Determine the amount of profit on the portion of the business subject to renegotiation under government regulations.
3. Determine costs applicable to individual cost-plus-fixed-fee contracts with government agencies and other contracts involving cost recovery provisions.

MANAGEMENT REQUIREMENTS. The legal and corporate requirements are provided for largely through cost-recording procedures. The more interesting and more complex work in cost accounting is that of providing **cost informational service** to management. Keller (Management Accounting for Profit Control) says:

> Practice which has evolved over a period of many years has broadened the scope of cost accounting from the basic function of recording costs in the accounts. Today cost accounting may be defined as the planning, determination, recording, analysis, and interpretation of the costs of producing and distributing products.
>
> Emphasis has shifted from the accounting functions to the management uses of costs. There are thousands of cost accountants who never make a journal entry or post a ledger. But they must know the relationship of the data which they use to the ledger accounts and the effect of transactions and decisions on the balance sheet and statement of profit and loss. Otherwise they cannot provide proper guidance to management.

Lang–McFarland–Schiff (Cost Accounting) describe the nature of cost accounting in these words:

> Cost accounting is an accompaniment of a movement in industry to which the general name of scientific management has been given. Actually the development of

cost accounting from a purely clerical function to its present position as an important tool of managerial control reflects in good measure the historical development of scientific management in industry. It is the aim of scientific management to make the most efficient use of the production facilities consisting of plant and machinery, tools, materials, and manpower. The cost accountant brings together the records of performance for this purpose and submits them together with his interpretive comments to management.

The **purposes** for which management requires cost data are many and varied, and the resultant information is of great assistance to management.

Measurement of Profits and Investment in Inventory. The dynamic character of business calls for reporting profits and inventory investment on a monthly basis (or more frequently in some businesses). This includes reporting of data by lines of product, by decentralized operating components, and by other significant segregations. Income and costs must be matched on a consistent basis to provide meaningful trend information and intelligent comparisons with budgets. Promptness in issuance of these reports is most important in enhancing their value to management. Only sufficient time should be allowed for month-end accounting work to develop a reasonable degree of accuracy in the figures.

Control of Costs. The basic tool for managerial control of costs is the **predetermined cost standard.** Continuous comparison of actual costs with standards, and prompt analysis and reporting of **unfavorable variances,** directs management's attention to the situations where corrective action is needed. Information of this nature may be developed in appropriate form for each level of management under the concept of responsibility reporting. Clearly defined areas of management responsibility are established, cost standards and budgets developed for each manager, and actual cost accumulated and analyzed for deviations from standard. The usefulness of cost control information is dependent to a large extent upon the careful development of good standards, and their acceptance as a fair yardstick, and the promptness and clarity of communication of variance data.

Budgeting, Forecasting, and Planning Future Operations. Budgets and forecasts are essential to the planning and direction of future operations of the company. Through this process, executive management determines the anticipated effect of the current planning on the company's future profit position and its capital requirements. If the predicted results are unsatisfactory, an opportunity is afforded to reappraise plans and change the course to be followed by the company. In the budgeting and forecasting procedure, the cost accounting department plays an important role in the determination of cost estimates and projections under varying conditions of factory load, product mix, new products, changed distribution channels, and other diverse situations. The effectiveness of the cost accounting personnel in this area depends largely upon the exercise of good judgment in sizing up each situation, creative analysis work, and a thorough knowledge of the behavior of costs in the particular business.

Specific Operating Decisions. Many operating decisions are made, or at least influenced, by giving consideration to information discussed under the foregoing three areas. Operating decisions, however, often require more **specialized cost information** which is developed with only one problem-solving use in mind. Examples include cost information prepared to assist in the evaluation of a proposed plant facility project, a change in a manufacturing process or method, the selection of the optimum design of a product or component, buy-versus-make decisions, pricing of individual contracts, models or product lines, selection of the

best distribution channel, and negotiation of changes in fringe benefit plans or other provisions of labor contracts.

To serve adequately all of these basic requirements of management, the cost accounting department is called upon to use a creative and ingenious approach. The greatest potential for improvement in current practice and the most important contributions lie ahead of the cost accounting department in providing management with better information for decision-making purposes. (For a detailed discussion of some of the important areas requiring decisions, see section on Special Cost Analyses.)

Department Functions

BASIC KINDS OF WORK. The work of the cost accounting department is founded on the foregoing objectives and on the basic function of **controllership.** The Controllers Institute of America (Controller, vol. 27) makes a statement of the controllership function which includes among the various elements of the controller's job the following three items:

1. To establish, coordinate and maintain, through authorized management, an integrated plan for the control of operations. Such a plan would provide to the extent required in the business, cost standards, expense budgets, sales forecasts, profit planning, and programs for capital investment and financing, together with the necessary procedures to effectuate the plan.
2. To measure performance against approved operating plans and standards, and to report and interpret the results of operations to all levels of management. This function includes the design, installation, and maintenance of accounting and cost systems and records, the determination of accounting policy, and the compilation of statistical records as required.
3. To measure and report on the validity of the objectives of the business and on the effectiveness of its policies, organization structure, and procedures in attaining those objectives. This includes consulting with all segments of management responsible for policy or action concerning any phase of the operation of the business as it relates to the performance of this function.

Much of this work of controllership is accomplished through the means of modern cost accounting techniques and falls within the scope of the cost accounting department.

The basic kinds of work required of the cost accounting department may be classified into the following categories:

1. Design, installation, and maintenance of a sound cost accounting system.
2. Accumulation of cost data.
3. Analysis of actual costs.
4. Cost estimating.
5. Reporting of cost information.
6. Counseling operating management on costs and cost relationships, including participation in cost reduction programs.

SYSTEM DESIGN, INSTALLATION, AND MAINTENANCE. The cost accounting system comprises the combination of procedures and methods followed by the cost accounting department in the determination of costs. It is the delineation of **what** work is performed by **whom, when,** and **how.** In a very broad sense the system may be referred to as a "job cost system" or a "standard process cost system," etc. The development of the basic objectives of the **cost accounting system** is of utmost importance to its future successful operation The design and installation of a cost system are only a part of the much larger job of organization and systemization of the entire plant or business unit. The

cost system should fit properly into the over-all **accounting system** and be integrated with the other **business systems** of the operation, such as the production control system. The cost information output of the system should be developed specifically to meet the needs of the business and the philosophies of its management.

In considering the objectives of a cost accounting system, it is of interest to note the position taken by Schlatter and Schlatter (Cost Accounting): "Any system which is operated only to show the end cost of the product is not the best system. Certainly the system must derive costs of products; but its more important function is to show where the leaks are that make the products cost too much, otherwise the cost cannot be controlled by management."

In their discussion of the subject, these authors have emphasized the use of process cost accounting and the establishing of safeguards at the points where costs enter the functions of production or distribution rather than at the points where they culminate as final cost of product made or sold.

Responsibility for the design of a new cost system or revision of the existing system frequently rests with the cost accounting department. In other instances this work is accomplished through a separate staff organization, an office procedures department, or an outside firm of accounting or management consultants. In the latter case the cost accounting department is normally in a position to exert some influence on the system design through contributing its own ideas for improvement and by making available its knowledge of plant problems, working relationships among plant personnel, etc. For a detailed description of the design, installation, and maintenance of cost accounting systems, see the section on Basic Cost Records.

COST DATA ACCUMULATION. There are three basic ways of obtaining cost information for management:

1. Classification and accumulation of costs in a way that will automatically provide the desired information for regular reporting.
2. Analysis of recorded cost data to obtain information that is not regularly reported but may be required to answer a special purpose.
3. Estimating of costs pertinent to a particular question to be answered for management.

In most business operations it is necessary to employ all three methods in order to provide economically the cost information required. It is not feasible on a continuing basis to provide for the automatic accumulating and reporting of all cost information to answer every question that management may raise. Cost data accumulation, however, should take into consideration not only the requirements for information to be regularly reported but should also permit and facilitate analysis and should provide a basis for estimating. In other words, cost accumulation should provide **information for regular reports** and also an **information inventory** to serve the needs of cost analysts and estimators.

The principal types of information collected by the cost accounting department are:

1. Costs by elements (material, direct labor, factory overhead, engineering, tooling, distribution, and administrative expenses) entering into the total cost of the product.
2. Cost of operating each department (work center or service center) of the business.
3. Excess costs classified by cause, such as excessive scrap, unusual maintenance, high material prices, and training of inexperienced employees.

4. Costs by job order, process, or some combination of the two.
5. Unit product cost and product line costs.
6. Costs of individual raw material items, labor operations, parts, and subassemblies.
7. Perpetual dollar inventories of raw material, parts, work in process, and finished goods. The cost accounting department work in connection with inventory frequently also includes responsibility for planning, supervising, and auditing the taking of physical inventories as well as costing and computing the final inventory figures.
8. Timekeeping and payroll data, in part or complete, depending upon whether a separate department has been assigned these functions.

The function of cost accumulating and recording contains a high clerical content. In organizing the cost accounting department, the recording job is frequently segregated from cost analysis and estimating in order to concentrate the time and effort of more highly skilled personnel on the latter type of work. In larger operations much of the calculating and record keeping can be mechanized through the use of conventional punched-card machines or electronic data processing equipment.

Companies selling goods or services to the United States government or its agencies under cost reimbursement contracts are confronted with special cost accumulation problems in the recording of costs and in the determination of what costs are allowable under the contract. **Contract cost principles**, including examples of allowable and unallowable costs, are outlined in Section XV of Armed Services Procurement Regulations. Since these regulations are subject to periodic revisions, the cost accountant responsible for costing such contracts should maintain contact with the U.S. Government Printing Office to obtain copies of new issues or changes in the regulations.

COST ANALYSIS. Vance (Theory and Technique of Cost Accounting) defines managerial cost analysis as "any calculation for management use from cost data beyond the figures provided in the regular cost accounting records." It comprises the work of examining available cost information to determine situations that should be called to the attention of management, the determining of relationships in data for use in estimating, and the search for information to improve the cost system or the accumulation process. The specific analysis work required will vary with the nature of the business and with the particular problem areas encountered in actual operations. The cost accounting department should normally be prepared, however, to undertake the following assignments:

1. Analyze and interpret for management the cost trend information and control data developed by the cost system, in order that plans and decisions can be based on a proper understanding of the pertinent facts.
2. Recognize the need for and recommend the establishment of routines and reports for improvement in control of costs and cost trends in manufacturing, engineering, and distribution components.
3. Initiate and participate in studies to determine that prices to be paid or costs to be incurred for materials, components, services, etc., are the most favorable that can be obtained.
4. Jointly with operating personnel establish, maintain, and audit cost standards for performance measurement and inventory valuation.
5. Prepare special analyses by sales territories, channels of distribution, classes of customers, size of orders, etc., to relate costs to results obtained for use by management in the guidance of marketing effort.
6. Prepare analyses required for the establishment of prices and discount structures.

7. *Prepare analyses required for renegotiation, redetermination, and other profit limitation or escalation provisions of sales contracts.*
8. Prepare analyses pertinent to preparation of budget and appropriation requests and to adjustment of costs with budgets or standards.

The effectiveness of the cost analysis work and its impact upon operating results depends entirely upon the **quality of the personnel** assigned. This type of work requires experienced individuals with good judgment, initiative, persistence, and creative ability. Properly executed, cost analysis provides the means of bringing to management's attention on a timely basis the important information which requires action and relieves management of the necessity of spending time on nonessential information.

COST ESTIMATING. Cost estimates may be classified into two broad categories: (1) estimates of actual costs incurred in the past and (2) forecasts of probable costs to be incurred in the future. Estimates of **past costs** are normally made to avoid doing a detailed analytical cost study or to avoid the expense of maintaining records in sufficient detail to obtain more accurate actual cost information This type of estimate is used in some companies which have no formal cost system for purposes of determining cost of sales. In companies where a cost system is in use, estimates may be applied in costing small parts billing or for other purposes where the expense of obtaining more accurate information is not warranted.

The forecasting of probable **future costs** in modern industry has widespread application. These estimates are required for budgeting purposes and for a variety of specific management decisions relating to setting of selling prices, making-versus-buying components, investing in new tools or equipment, changing of methods or processes, selecting channels of distribution, and comparing alternative product designs. Estimates of costs may be required for a complete product, a component, a subassembly, a process, a job, or a function.

The extent to which responsibility for cost estimating is placed in the cost accounting department may vary among companies. In some instances a separate organization component outside the cost accounting function performs this work. Other companies place the primary responsibility with cost accounting while recognizing that the preparation of cost estimates requires team effort on the part of design engineers, manufacturing planners, and cost accountants. This is a logical solution because the historical cost records maintained in the cost accounting department provide much information which is valuable in estimating. It is desirable, therefore, in the development of the historical cost-data accumulation system that consideration be given to the needs of cost estimating as well as the cost analysis and reporting functions. For example, if product cost estimating is to be done by the use of formulas based on certain product characteristics, historical cost data should provide for ready classification by these product characteristics so that the adequacy of the formula may be checked periodically. (For a detailed discussion of cost estimating see section on Estimated Costs.)

REPORTING. The reporting function may be defined as communicating to management the selected information needed to control and plan operations. Neuner (Cost Accounting), in referring to cost reports, states that reports to management must summarize the essential facts of production and also distribution in understandable and usable form so that the executives of a firm may:

1. Measure the effectiveness of the various manufacturing and distribution functions of the firm.

2. Hold various supervisory personnel responsible for controlling costs, knowing that they have been provided with timely and detailed information to assist them in taking corrective action on excessive direct material, direct labor, and controllable overhead costs.
3. Study the trend of operating costs of specific types of material, labor, and overhead expenses.
4. Plan future production and distribution policies for the entire firm.
5. Make specific price, production, financial, and labor policy decisions based on adequate cost information appropriate to the particular problem.

Executives of well-managed companies are guided in their decisions by facts and suggestions presented by the cost department. These frequently arise in the cost department's daily handling of the many detailed operating figures which show the weaknesses and strengths of the current methods of doing business. Such suggestions, if acted upon, are an aid in:

1. Controlling day-to-day activities.
2. Effecting cost and expense reductions.
3. Establishing broad policies, such as those relating to plant improvement and enlargement.

The manner in which this information is presented can win the respect and confidence of the recipients and speed up the taking of management action. A sound rule to follow is to furnish information first to the manager directly in charge of an activity before advising his superior, particularly if the report is unfavorable. This often permits the taking of **immediate corrective action** which can be reported to the next echelon of management coincidentally with the information relating to the unfavorable condition. Careful consideration in handling such matters promotes the finest kind of teamwork and enhances the reputation of the cost accounting department at all management levels.

The importance of the information-reporting function cannot be overemphasized. The data collected by cost accounting has no value to management unless communicated to each operating level in understandable form. The **simplicity** of the report, written or oral, and its **speed** are highly significant features. A reasonable degree of accuracy rather than theoretical accounting precision is preferable to delay of the information. To be truly effective in this area, the cost accountant must acquire a sense of urgency and must develop an intimate knowledge of the business operation to enable him to furnish information for **preventive action** as well as **remedial action** by management. (For a detailed discussion of cost reporting see section on Cost Control, Budgets, and Reports.)

COUNSELING. Counseling is defined as advising, mutual advising, deliberation together, and recommending an act or course. A part of the cost accountant's function is advising and deliberating with operating management on costs, cost relationships, and ways of making cost improvements. Counseling is illustrated in the following examples:

1. The systematic exploration (by operating personnel with the assistance of cost analysts) of **reasons for cost variances** and the causes and conditions that create them.
2. Participation in **special studies** undertaken to solve specific operating problems where management requires analysis, estimate, or interpretation of cost data.

3. Participation in the continuous drive by engineering and manufacturing personnel for lower costs. This activity is given formal recognition in many operations through **cost reduction programs** which are incorporated in the annual budget.
4. Assistance in the **training of new management personnel** by teaching and explaining the cost accounting system, the nature of cost information available and the significance of data included in standard reports.

Although the last two activities may vary in their application in different companies, participation of the cost accounting department can materially increase the effectiveness of the accounting function. With respect to cost reduction programs, some shops have a **cost reduction team** set up for each area of the shop. Each team develops a list of projects to be worked on, target dates for completion of each project, and a budget in dollars of the anticipated reduction in cost. The teams include a representative from engineering, one or more from manufacturing, and frequently a cost analyst. The work of the cost analyst is (1) to furnish sound cost data so that the team effort will not be misdirected, (2) to evaluate the ultimate cost saving, and (3) to use his ingenuity jointly with the other team members in discovering or developing the way to obtain the desired cost reduction. He also frequently maintains records on the projects and issues progress reports to management. This can develop into a key position on the team, particularly if the cost accountant is of an aggressive and persistent nature. At a minimum it provides close working contact between accounting and operating functions and affords the opportunity for the cost analyst to make a measurable contribution to operating results.

The effective use of cost accounting information is largely dependent upon the confidence with which management views it. This confidence is built on eliminating the mystery from the figures and developing good relations between the user of the information and the one who prepares it. An excellent opportunity to accomplish both these goals is afforded when a new managerial appointment is made in the operating area. The cost accountant should furnish a simple and understandable explanation of the cost accumulating and estimating system and the type of information and service he is prepared to furnish. During the first few months sufficient time should be spent with the new manager to assist him in the interpretation of standard reports to build up his confidence in the usefulness of the information.

Relations with Other Functions

INTEGRATING COST ACCOUNTING WITH THE OPERATING TEAM. One of the most important aspects of the job of manager of the cost accounting department is the maintenance of good working relations with the other departments in the business operation. The attitude of the cost accountant and his entire staff must be one of helpfulness. Their role should be established as **participating team members** and not as judges or umpires. As members of the business team, all departments, including the cost accounting department, are working toward the same objective of steady growth in the profitability and size of the enterprise.

Nearly all departments of a business are dependent upon the cost accounting department for information. Likewise the cost accounting department is dependent upon many of the other departments for the basic data from which costs are compiled and analyzed. This interdependence requires a complete and willing cooperation on the part of all parties to assure that management will

receive and make use of timely and effective cost information. In the subsequent text some aspects of the relations with the more important departments are discussed.

MARKETING. The modern concept of the function of the marketing department is much broader than that of the old sales or distribution departments. Today marketing includes the following elements:

1. Planning of the product, including planning of the selling price.
2. Market research.
3. Advertising and sales promotion.
4. Selling, including selection of distribution channels, distributors, agents, and types of retail outlets.
5. Product service, including provision of renewal parts and in-and-out warranty service.
6. Administration, including sales forecasting, budgeting, warehousing, finished stock inventory control, and order service.

It is obvious that a marketing department having these responsibilities has a considerable need for cost information. This has prompted some businesses to establish the position of **marketing cost accountant** or distribution cost accountant to specialize particularly in the compilation and analysis of cost data useful to marketing management. This field of activity is not well developed by comparison with traditional factory cost accounting. There is, however, a growing awareness of the need for concentrated effort in the application of cost accounting techniques to many of the marketing functions.

Marketing management needs cost information for planning, for control and measurement, and for specific decision-making purposes. The types of **marketing information** may be delineated as listed under the next three headings.

Planning Information.

1. Estimated future product costs for establishing published selling prices.
2. Estimated distribution cost differentials to establish price structures for quantity discounts and for various sales channels.
3. Cost and/or profit estimates and comparisons for alternative selling methods, sales plans, distribution points, warehouse stock levels, and advertising and promotion programs.

Control Information.

1. Actual cost and expense comparisons with budgets or standards for each supervisor.
2. Reports on sales, costs and expenses, and net profit by product line, territories, classes of customers (channels of distribution), and method of sale.
3. Unit handling costs in warehousing, shipping, and order service.
4. Cost trend reports on in-warranty service.

Information for Specific Decisions.

1. Product cost estimates for specific propositions involving custom-built equipment or other specials not listed in the price catalog.
2. Variable product cost information to assist in directing sales effort to most profitable lines or for other special purposes.

These data do not constitute a complete catalog of information for marketing but are representative of the service that cost accounting can render to this function of the business. In addition, benefits can be produced in some operations by

joint participation of cost accounting and marketing personnel in the study or analysis of specific marketing problems involving cost considerations. The unique contribution of the cost accountant can be his knowledge of the behavior of costs and his analytical ability which has been developed through training in the disciplines of accounting.

PRODUCT ENGINEERING AND DEVELOPMENT. The responsibility for developing and designing new or improved products is normally assigned to a separate organizational component under an engineering manager. This department maintains a close liaison with marketing personnel to assure that engineering effort is directed toward products and product features which will receive favorable customer acceptance. One of the important considerations in **product design decisions** is that the end product will yield an attractive margin to the business. It is essential that the prices planned by marketing be compared with cost estimates prepared by the cost accountant before designs are released for production. In today's competitive business, various **alternative designs** for components and assemblies are considered by engineers, manufacturing planners, and cost accountants before final production release decisions are made.

In addition to costs in connection with studies of designs, the cost accounting department feeds back to the engineering department information relating to: (1) spoilage and other extra costs incurred because of an engineering error or a cause attributable otherwise to engineering, (2) costs of correcting product quality difficulties attributable to engineering, and (3) costs of the engineering function, analyzed by projects, by major types of expenditure, etc., compared with the budgeted costs.

The cost accounting department is dependent upon engineering for much of the basic information required for preparing cost estimates and cost standards. The **specifications** of type and quantity of material to be used are issued by engineering. This forms the basis for the ordering of materials and parts by the factory and also for the preparation of estimated or standard costs by the cost accounting department. Since designs seldom remain static, engineering authorizations for substitutions of material or for other changes are issued to the factory frequently, and these likewise must flow into the cost accounting department to be reflected in the product costing. These close interrelationships with engineering require a close coordination or complete integration of the paper-work systems between the two functions.

MANUFACTURING. The manufacturing function includes all the work involved in converting the engineers' design into a finished product ready for delivery to the customer or finished stock warehouse. This includes the function of purchasing in some business organization structures, while in others the purchasing function is set up under a separate executive who is not responsible for production. Most of the cost accountant's time in a manufacturing company is devoted to working on costs incurred in the production of the product. It is in working with personnel in the manufacturing organization that he normally makes his greatest contribution to the success of the enterprise.

The team of experienced British accountants who spent two months visiting American companies observed in their report for the Anglo-American Council on Productivity (Management Accounting), "The friendliness and understanding between the controller's department and the production department is remarkable. The controller's department is looked upon as an essential service to production."

Heckert and Willson (Controllership) offer some specific examples of cost information which the accountant can secure and interpret for the production staff:

1. Comparison of actual and standard man-hours or labor costs.
2. Comparison of budgeted and actual manufacturing expenses.
3. Comparison of actual and standard material costs.
4. Comparative cost of different manufacturing processes.
5. Maintenance cost of different pieces of equipment (for assistance in determining when to purchase new machines).
6. Standard man-hours required for anticipated production schedule.

Industrial Engineering. While there is considerable difference of opinion as to exactly what is included in industrial engineering, it frequently includes (among other activities) time and motion study and rate setting, wage incentives, job evaluation, plant layout, equipment specification, and development of operational sequences. In some cases "manufacturing engineering" denotes approximately the same functions as "industrial engineering."

Basically the objective of industrial engineering is to provide the facilities and technical planning that will establish optimum production conditions from the standpoint of output, quality, and cost. The cost accounting department must work very closely with the industrial engineering group in estimating and checking the effects on production costs of the various alternatives constantly being considered and evaluated. A substantial share of the effort of the industrial engineer is devoted to attaining lower labor costs. (For methods to reduce labor costs, see the section on Setting Standard Costs.)

The operational steps for manufacturing each part, subassembly, or assembly are determined by the industrial engineering department and detailed on **operating planning cards.** These cards show the work stations where each task is to be performed, describe the work to be done, and indicate the standard allowed time per unit of production and the applicable labor rate. The operation planning cards are used by the cost accounting department to develop the standard labor cost of each component and the complete product. In some companies cost personnel and rate setters work from a single operation planning card file, and notification of changes is virtually automatic. Where this system or something comparable is not in place, cost personnel should conduct periodic audits of standards to determine that their information is up to date.

Purchasing. To the cost accountant it is important to establish a relationship with the purchasing activity that will provide for a free flow of information between the two organizations. The cost of purchased materials and supplies in many products is equal to all the labor and other costs combined. **Material** and **supplies,** therefore, represent items in which the cost accountant should take a very active interest because of their relation to control and their importance as a source of substantial cost reductions.

The assistance of cost accounting can be effectively used in such situations as the following:

1. Where items of a somewhat special nature are being purchased, cost estimates should be furnished as a guide to the purchasing department in evaluating the fairness of price quotations.
2. Fluctuations in quality, grade, or size of material which affect direct labor costs, life of cutting tools, or other costs should be brought to the attention of the purchasing agent and product engineer by a request for change of source of supply, change of specification, or other action.

3. Cost of correcting faulty material should be reported to the purchasing department for billing back to the vendor.
4. Cost of idle time and other extra costs incurred due to the vendor's fault of delivery or product quality should be reported.

In placing business with vendors, good purchasing practice gives consideration not only to **price** but also to **quality** and **service.** The cost accountant should be alert to opportunities to assist in the evaluation of all three of these factors in terms of their effect upon the cost of operations.

During periods when prices of materials are changing, the purchasing agent should keep the cost accounting department advised of important changes in quoted prices. This enables the cost accountant to revise product cost calculations and to notify the marketing department of the changes as a guide to accepting future orders. The purchasing agent should also assist the cost accounting department by furnishing latest price information when standard costs are being revised and when year-end inventory valuations are being determined. (For detailed descriptions of the purchasing activity, see Accountants' Handbook, Wixon, ed.)

Production Control. According to the Production Handbook (Carson, ed.), "Production control promotes effective shop operation through its control of activities within the production department itself." It is primarily concerned with scheduling the activities in the manufacturing operation to meet the output objectives with optimum effectiveness. This includes:

1. Planning and scheduling individual production orders in job shops or production rates in mass production operations.
2. Determining the work load for each work center, and coordinating the use of manpower, materials, and machines for the production program.
3. Determining the quantities of raw materials to be ordered and to be maintained in stock and of component parts to be produced and carried in inventory.
4. Preparing and releasing detailed instructions to the purchasing group and to the shop for ordering of materials and performance of work in accordance with the production plan.

The production control department acts as the **nerve center** of the factory. It works closely with marketing in making shipping promises to customers, determining production schedules, and making changes in schedules to meet the needs of customers. At the same time it must make these changes at minimum cost, maintain reasonable stability of shop employment, and keep inventories under control. Since it prepares and releases the ordering instructions for purchase of materials and performance of work in the shop, it is obvious that the timing of the expenditure of money is largely in the hands of the production control function. These instructions are the authorizations for purchasing to place orders on vendors and for the direct labor employee to cut metal in the shop.

Production control is dependent upon other departments for the technical information included in its instructions. The engineering department provides the detailed **material specifications,** the quantity and quality for each part. Industrial engineering furnishes detailed **operation planning** to cover the processing of each item in the shop. The function of production control is to determine the **production quantity** and **timing** and to prepare and distribute the necessary instructions to initiate activity.

It is relatively easy for the cost accountant in many operations to become the production control man's severest critic when changes in schedules have

created excess costs, inventories have gotten out of control, uneconomical lots are being processed through the shop, or any one of a dozen other cost-increasing occurrences have taken place. This tends to demonstrate that a close working relationship between cost accounting and production control should pay off if warning signals could be raised in time to eliminate or reduce these cost leaks.

Among the opportunities that cost accounting has to be of assistance to production control are the following:

1 Maintain meaningful analyses of actual inventories and develop and maintain with production control a system of forecasting inventory levels based on commitments for incoming vendor material, planned labor loads, and estimates of output.

2. Furnish direct labor data by work centers which may be utilized in factory loading determinations. Standard direct labor data must be modified by past and expected future experience with respect to labor inefficiencies, such as rework, spoilage, training time for inexperienced employees, etc. The cost accountant's records of these items should be useful in providing a more accurate basis for calculating capacity of each work center.

3. Furnish cost data required to calculate economical ordering quantities. Day-to-day calculations are frequently done by formula. The cost accountant's judgment should be of value in developing with the production control specialist a sound and reasonable formula for the particular business. Specific cost information required may include set-up costs, costs of warehousing and handling inventory, and obsolescence losses.

4 Prepare analyses to pinpoint the probable areas of cost increases which would result from schedule changes. Such analyses should be useful in assisting operating personnel to minimize costs resulting from such changes.

The **factory inventory** is probably the greatest area of common interest between cost accounting and production control. In most shops, if the inventory increases abnormally during a month or if there is a sizable deficit between the book and physical inventory at the year end, the accusing finger is raised at either of or both these two organizational components. The cost accountant is told that he must have undercosted shipments all year and the production control man that he has let someone steal or waste his stock. This area of common interest also provides an excellent opportunity for cooperation in minimizing the cost of taking the annual physical inventory. The cost accountant usually is held responsible for taking and compiling the inventory. It is only with assistance from the production control and shop operations departments that an inventory can be taken in a reasonable period of time. In some companies, techniques have been worked out between cost accounting and production control which have eliminated the problem of interrupting production and have minimized the amount of overtime work involved in physical counts. One such technique is the use of **perpetual inventory records** on stock items maintained in production control for ordering and stock control purposes. Actual precounts of stock are made during the several weeks preceding the physical inventory date, and perpetual inventory records are adjusted accordingly. At inventory date the stock card record balances are used for inventory purposes. Cost accounting, to assure itself of the accuracy of the procedure, makes test counts on inventory day for comparison with the perpetual inventory record. (For a detailed description of accounting for inventories, see Accountants' Handbook, Wixon, ed.)

Stores. The part of the production control function concerned with custody of materials and the maintenance of stock records is often referred to as "stores" or "storeskeeping," which is closely related to cost accounting.

Heckert and Willson (Controllership) observe that the proper accounting for and control of materials have the following advantages:

1. Reduce inefficient use or waste of materials.
2. Reduce or prevent production delays by reason of lack of materials.
3. Reduce the risk from theft or fraud.
4. Reduce the investment in inventories.
5. May reduce the investment required in storage facilities.
6. Provide more accurate interim financial statements.
7. Assist buyers through a better coordinated buying program.

The satisfactory operation of most cost accounting systems is dependent to a considerable degree upon the performance of stores' personnel. Although this will vary with different cost systems, the cost accounting department may require from storekeepers such information as the following:

1. The reporting of material quantities withdrawn from stock.
2. The job numbers, operations, processes, or departments to be charged for materials withdrawn.
3. A record of finished parts and products delivered to stockrooms from production.
4. A record of returned materials, showing job numbers, operations, processes, or departments to be credited.
5. A record of scrap delivered to stores.

Usually finished parts and supplies are kept in the stockrooms until required, although some stocks of raw materials and parts are kept on the production floor rather than in centralized stockrooms. These are frequently referred to as **open stockrooms** and have been established in many shops to minimize material handling. Storeskeepers normally have control of all materials, regardless of their location, to minimize damage and pilferage and to assure proper reporting of receipts and usage. Storeskeepers are especially trained to recognize the importance of material requisitions, returned materials credits, bills of materials, and other papers required by cost accounting for preparing the basic accounting entries to **inventory** and **departmental expense accounts.**

Some companies locate **stores records** in the stockrooms where the material is located. Many companies, however, have found it advantageous from control and economy standpoints to maintain the stores records in the production control office, using either manual or mechanized methods. In addition to recording on these records the physical quantity data, it is also customary in some companies to carry unit cost information on the stores record. Under this system, stores personnel are responsible for showing on withdrawal requisitions and other papers the unit prices for use by cost accounting in preparing accounting entries.

In some companies the stores records are considered to be a part of the general financial records of the company in that they support and record the details of the inventory accounts. As a minimum the cost accountant has a sufficient interest to make or arrange for **periodic audits** of the system and records and the stores areas to assure that the information he receives is accurate and that the materials, parts, and products are being adequately protected from a physical standpoint.

Quality Control. The function of quality control is to assure that the final product meets engineering specifications. This involves providing **inspection** and **test operations**, at various stages of the processing, on purchased materials and components, and on the final completed product. The proper planning and execution of this function can have a pronounced effect upon the level of quality

performance attained in a shop and upon the total cost of the product. The quality control department determines what inspection operations and tests are required and interprets the results of the inspections and tests. To determine causes of excessive failures, it also makes analyses in conjunction with product engineering, industrial engineering, and shop operational personnel.

Quality control and cost accounting have a mutual interest in the measuring and control of excess costs due to quality difficulties. Inspectors' reports furnish the basis for determining the quantity of good work produced, the quantity which is faulty, the work to be scrapped, and the portion of production that may be reclaimed through rework operations. In some companies these reports also assign the responsibility to the department or foreman causing the excess costs so that statistical reports by department or foreman may be furnished to management. The cost accounting department receives copies of **inspectors' reports** authorizing the scrapping of faulty material, parts, and products, and it then develops the dollar value of scrap for statistical reporting, developing of standard scrap allowances, and variances.

Shop Operations. Shop operations is responsible for the day-to-day production activity on the factory floor, the manning and operating of the machines and processing equipment which makes the product. There is a considerable difference among companies in the responsibilities assigned to supervisory personnel in shop operations. In some organizations foremen are assigned rather broad responsibilities (including such functions as dispatching and timekeeping) and play a major role in collecting cost data and other detailed information. Other companies limit foremen's activities to supervision and training of direct labor personnel and assign the clerical duties to other functional areas.

Many of these clerical duties are of a liaison nature between shop operations and production control or payroll and cost accounting. The dispatching and timekeeping functions are typical of the liaison work required between shop floor and office. The main assignment of **dispatchers** is to release orders to the shop to proceed with production of specific items. These clerks also check to see that orders are processed on schedule, using the standard manufacturing method, and that the parts are moved on to the next operation. Records are maintained of the status of each order and the quantities produced so that appropriate action may be taken as difficulties are encountered, such as shortages resulting from unusual scrap losses, delays due to machine downtime, etc.

The **timekeeping function** is performed to assure accuracy of payroll payments and to assist in the accounting for and control of labor costs. Direct labor employees' time is divided between that applied to production work and that spent in indirect manufacturing work. The **production work** is covered by the standard labor value of completed units of production and in some operations may be paid for on a piecework basis. The **indirect manufacturing time** is classified as to type and charged to the appropriate cost account. Descriptive statements relating to unusual incidents affecting costs should be entered on the time sheets.

Both timekeeping and dispatching require a close contact with the work in the shop. It is also easily discerned that these two functions are closely related, although serving somewhat different purposes. In some plants the two functions have been combined under the direction of the production control department, the cost accounting department, or the foreman in shop operations. When such combinations are made, it is essential that the interests of the payroll function be adequately protected by requiring the paymaster to maintain a strong functional control over the timekeeping portion of the activity.

Regardless of who performs the clerical work related to shop operations, the foreman has the right to expect that he will currently receive information relating to the performance of his component. With respect to cost information, this should be supplied by the cost accounting department and should include significant analyses of labor costs and all other items for which the foreman is responsible. The cost accountant will also find many other opportunities to assist the foreman, such as making cost evaluations of employee suggestions or other cost improvement ideas, advising him in connection with budget preparation, and calling to his attention unusual items of cost that the accountant has noted, such as high-cost supply items. Many of these helps can be rendered orally on a friendly basis. This type of contact is usually more effective than the written memoranda approach.

INDUSTRIAL RELATIONS. The work of the industrial relations function comprises the procedures involved in developing pay rate schedules for employees, employee benefit plans, personnel practices, health and safety measures, education and training programs, negotiations with unions, and good public relations for the company. The effect of these activities on operating costs has become of increasing importance during the past few years. For example, **fringe benefit costs** related to pensions, life insurance, hospitalization, paid holidays and vacations, unemployment benefit plans, and others have become the fastest rising single item of cost in many companies. The cost accountant needs to study carefully all the fringe benefit plans in effect in his company to assure himself that he is making proper provision in his costs for their long-term as well as their short-term effects (see section on Labor Costs).

It is very important that the controller and his organization work closely with industrial relations personnel when union contracts are being negotiated or when other matters having cost or record-keeping implications are being considered. As an attorney who has had extensive experience representing industry in labor negotiations, Wayman (NAA Bulletin, vol. 35) writes,

> In my own experience, the computation of these fringe costs has generally been done "under the gun" in negotiations by a lawyer or industrial relations man, using his own rule of thumb. This method is roughly comparable to guessing the number of jelly beans in the jar in the drug store window. . . . As a negotiator I welcome—nay, I yearn for—the help of the trained accountant before, not after, the deal is made. Sooner or later management must recognize this and put the accountant into the front line combat team.

Basic facts and figures relating to the effect on costs of union demands or of proposals made by the company should be prepared by the controller's organization. Proposed contracts and contract changes also need to be examined to determine the record-keeping and other administrative requirements. These more frequently than not become the responsibility of the payroll department or involve the timekeeping function. During other periods, cost estimates of various types may be required for specific purposes in handling the industrial relations function, such as the determination of cost of strikes, employee absenteeism, work stoppages, time spent on grievances, accidents, and training personnel.

A check list of possible functions of the controller in labor negotiations and in other industrial relations matters is given by Heckert and Willson (Controllership):

Directly in Labor Negotiation Matters.

1. Develops and supervises the maintenance of company records which will provide essential data for labor negotiations.

2. Analyzes the union contracts and suggests changes which may be desirable from a cost or operating viewpoint.
3. In collaboration with the personnel manager, anticipates the data needed in negotiations, and takes steps to make such available.
4. Serves as a member of the policy committee on collective bargaining.
5. Determines the cost—perhaps in the aggregate—per unit of product.
6. Supervises the gathering of outside financial data on pertinent matters.
7. As requested by the negotiator, presents figure-facts and interprets them during the negotiations.
8. Analyzes the probable effect on the operations of decisions reached in labor negotiations, and makes plans so that the policies and operations may be adapted to meet best the competitive economic conditions.
9. Prepares financial data to secure public support, where necessary, in connection with negotiations.

Other Industrial Relations Matters.

1. Renders the usual services related to payroll matters—prompt and timely preparation of pay checks, maintenance of necessary records required by law, handling of payroll deductions, etc.
2. Cooperates with the industrial relations department in interpretation of the contract provisions regarding wage payments as applied to the everyday problems which arise.
3. Assists in the development and installation of wage incentive systems.
4. Assists the union in accounting matters, including statement preparation relative to union business.
5. Supervises or gives advice relative to credit unions, insurance plans, and similar matters.

Heckert and Willson point out that the degree to which the controller functions in such matters depends upon a great many factors such as: the size of the company, type of accounting system, personality of the controller and that of the personnel or industrial relations director, type of bargaining, physical location of the offices, and relative rank of both executives.

ACCOUNTING. The cost accounting department has a close working relationship to other departments in the controller's organization, particularly the general accounting, payroll, and budgeting departments. This arises primarily from the fact that each of these components is either dependent upon cost accounting for cost details, journal entries, and similar basic data or is responsible for providing cost accounting with material for its analysis and use.

General Accounting. Neuner (Cost Accounting) describes the very close tie-in between general and cost accounting:

> Financial or general accounting is concerned with classification, recording, and interpretation of business transactions so that periodically summary statements can be prepared, indicating either the historical results of these transactions or the financial condition of the business at the end of the final period. This accounting provides management with the total cost of manufacturing a product or rendering a service. If there are many different products or services, the total results are not too helpful for control purposes. Therefore, it has become necessary to expand the general accounting procedures so that it will be possible to determine the cost of producing and selling each article or of rendering a service, not at the end of the fiscal period but at the time the article is being manufactured or the service is being rendered. Only by having immediately detailed figures of the cost of material, labor, and manufacturing overhead, as well as selling and administrative expenses for each product, can management exercise effective control. Cost accounting is

therefore an expanded phase of the general or financial accounting of a business concern, which provides management promptly with the cost of producing or selling each article or of rendering a particular service.

An examination of the functions for which the **general accounting department** is normally responsible illustrates in more detail the day-to-day working relationship with cost accounting:

1. Maintaining the **controlling books of account:** the general ledger, accounts receivable, and other ledgers and records of original entry such as the voucher register. Detail records supporting certain entries to these accounts are retained in the cost accounting department and in the payroll department. In most instances it is normal practice for these latter departments to be responsible for preparation of journal entries or summary data which is transmitted to general accounting for entry.
2. Maintaining the **plant asset records.** Depreciation charges on building and equipment are prepared from these records and furnished to cost accounting.
3. Preparing **balance sheets, profit and loss reports,** orders and sales statistics, and other summary reports. Data supplied by cost accounting are incorporated in many of these reports.
4. Preparing **tax returns,** reports for insurance coverage, and similar legal or corporate information returns. The work done by the cost accounting department in determination of costs for inventory values is particularly pertinent to these reports.
5. Paying **vendors' invoices** and making similar disbursements other than for payroll. This work is normally performed by the general accounting department, although in some operations the responsibility has been placed in the cost accounting department. For its purposes, cost accounting must receive a memorandum of invoices for direct material and various cost items or have the original invoice clear its records before passing to the general accounting office for payment.
6. **Billing to customers.** The preparation of invoices to customers, their summarization, and recording is done by general accounting. Closely related to this work is that of making the corresponding entry for cost of sales. For mass production products this is normally done by applying standard unit costs for each model to the total units for each model sold during the month. For custom-type equipment this becomes a problem of costing each individual shipment. Under either situation, the necessary cost information must be furnished to general accounting by the cost accountant in order to permit making the cost of sales entry.

Payroll. In recent years the payroll function has become sufficiently important and complex in many companies to be established as a separate department. This component is responsible for determination of gross pay, payroll deductions, and net pay for each employee as well as the actual disbursement of moneys or a check to the employee. In addition, the maintenance of records of employee earnings, participation in benefit plans, and various other data relating to the employee are kept in the payroll file. The financial administration of employee benefit plans and the preparation of withholding tax, social security, and unemployment tax returns are logically placed with the payroll function. (For discussion of payroll see section on Labor Costs.)

In some operations the **timekeeping** function is also under the direction of the payroll department, including the responsibility for accounting distribution of gross earnings of employees. In other organizations the cost accounting department may perform these functions. Since the timekeeping activity is basic to accurate payment of employees, the payroll manager will want to exercise at least functional control of this work. The joint interest of payroll and cost accounting in the control of payments for labor necessitates a flow of information between the two components under either form of organization.

Budgeting. A budget may be defined as an expression of a business plan in terms of money. Before final adoption, budgets and business plans are subjected to review and modification to permit laying out a course which will meet the profit objectives of the management.

The budgeting department is assigned responsibility for planning and coordinating the **budget program** and providing for the continuous comparison of actual results with the budgets.

Much of the data required in preparation of the budget and in making analyses of subsequent comparisons of actual results with the budget originates in the cost accounting department. Operating managers in manufacturing and other functions rely heavily on the well-informed cost accountant for specific actual cost details and projections of cost trends in the **preparatory budget work.** During the year the cost accountant should assist operating managers in anticipating the trouble spots which will cause budget overruns on costs unless preventive action is taken.

In discussing the functions of accounting in budgeting, Heiser (Budgeting—Principles and Practice) points out that good budgeting requires a high level of account organization and accounting procedure and emphasizes that cost data are a prerequisite:

> Cost accounting is . . . a "must." Moreover, the use of standard costs, while not a prime requisite, greatly facilitates budgeting and other control procedures. Knowledge of unit product costs, for all products, is needed not only in pricing but also for facilitating the preparation of cost forecasts under varying conditions of volume and sales mix, as well as for the prompt analysis of alternative courses of action, consideration of which is an integral part of budgeting. Especially with reference to factory burden, budgeting relies heavily on accounting determinations. The determination of the burden absorption rate is a prerequisite to product costing, and the budgeting of burden items and related cash requirements constitutes a major task in budget preparation. For both these purposes, the accounts must provide detailed information of the relation of burden to production volume.

In his relationship with the budgeting department, it is expected that the cost accountant will assist in the **evaluation of the budget.** Management must have reasonable assurance that budgets are based on a good but attainable standard of performance and are not based on laying out a "soft job" for the operating components. Within the controller's organization the cost accountant, because of his intimate contact with day-to-day operations, is in an excellent position to make a valuable contribution toward the establishment of fair measurements. (For further details on budgets, see the section on Cost Control, Budgets, and Reports.)

Departmental Organization

PLACEMENT IN COMPANY ORGANIZATION STRUCTURE. Organizing is one of the basic and inescapable functions of managing. Its purpose is to bring people together in the way that will provide the most effective working relationships. Since organizing is more an art than a science, individual company structures show a variety of forms reflecting the judgments of different managements. With respect to the cost accounting department, there has always existed some difference of opinion as to whether it should be under the direction of the factory manager or under the accounting executive. Proponents for estab-

lishing cost accounting under the **manufacturing manager** base their position on the following arguments:

1. The cost accounting department is primarily concerned with keeping records and developing information relating to factory operations.
2. It exists to serve the manufacturing organization and cannot properly do so unless it reports to the manufacturing manager.
3. Its main objective is cost control.

On the other side of the argument, the reasons for establishing the cost accounting department under the **controller** independent of the manufacturing organization, are:

1. Cost accounting work is merely one phase of the total accounting job, and it should be integrated with general accounting, payroll, and other activities of the controller.
2. Values developed in cost accounting for inventories, costing of shipments, and various other financial statement purposes should be the direct responsibility of the controller.
3. The kinds of work performed and the techniques used in cost accounting require an accounting specialist for proper direction.
4. Cost accounting exists to serve the needs not only of manufacturing but also of marketing, product engineering, and general management. It should be placed in a neutral position to assure that information and reports are not unduly influenced by the manufacturing function and that a balanced service is performed for all functions.
5. One of the major objectives of the cost accounting function is to assist management in the direction and control of costs. This includes all costs of operating the business, not those relating only to manufacturing.

Manufacturing companies have, in general, organized the cost accounting function under the controller. This plan of organization has been given impetus in recent years with the increasing recognition of a new concept referred to as **management accounting**. Keller (Management Accounting for Profit Control) states that cost accounting is the keystone of management accounting. With respect to organization for management accounting, Keller says:

> All phases of management accounting are conducted most efficiently if they are under the responsibility of the chief accounting officer. . . . This concentration of responsibility under the chief accounting officer is desirable for reasons of consistency, efficiency, and independence. Management accounting information must be consistent with the information recorded in the books if it is to be reliable and is to be accepted throughout the organization.

There appears to be little doubt that the arguments for placing responsibility for cost accounting under the controller are logical and powerful. In single-plant companies this can be accomplished readily in the organizational structure because the cost accountant can be authorized to report directly to the controller. In multiplant operations a partial compromise may be required under which the local cost accountant reports administratively to the plant manager and functionally to the controller. A research study by the Controllership Foundation (Centralization vs. Decentralization in Organizing the Controller's Department) states:

> Until further studies can be made on this point, the evidence cited here indicates that a division of formal authority over the factory accountant is entirely workable, provided that the controller's department has acceptance and support of company

manufacturing executives. A man can serve two masters, provided that the two masters are not working at cross-purposes.

RELATIONS WITH CONTROLLER. The functions of the controller, as determined from a study of a number of company organization manuals. job descriptions, and interviews, are summarized (American Management Association Research Report No. 20) by Dale as follows:

1. Providing basic information for managerial control through formulation of accounting and costing policies, standards and procedures, preparation of financial statements, and maintenance of books of account; direction of internal auditing and cost controls.
2. Budgeting and control of operations and results.
3. Specific control activities.
   a. General accounts, primary and subsidiary accounts; devising checks on the company's finances and safeguarding its assets; checking invoices, accounts receivable and payable; controlling cash payments and receipts, payroll accounts, fringe benefits, plant and equipment records; cost accounting activities of the various management functions.
   b. Preparation and interpretation of regular financial reports and statements
   c. Inventory control.
   d. Statistics.
   e. Taxes.
4. Internal audits.
5. Interpretation of control data.

In the **organizational structure** the controller may report directly to the president or to the financial vice president. In some instances the functions are the responsibility of the treasurer. Dale's study for the American Management Association showed that in 59 of 141 companies of large and medium size, the controller (or comptroller) reported directly to the president. A Controllers Institute committee recommended (Controller, vol. 20) that, "The controller should be an executive officer at the policy-making level responsible directly to the chief executive officer of the business. His appointment or removal should require the approval of the Board of Directors."

A major contribution of the controllership function has been the assistance rendered to management at all levels in the **direction and control of operations.** This assistance is based on furnishing factual data and interpretations founded on sound accounting and costing principles. With respect to the relationship of the cost accountant to the controller, it should be kept in mind that figures compiled in cost accounting are utilized at various management levels and become integral components of many reports, including those going to the board of directors. In performing the duties assigned to him, the manager of the cost accounting department has the specific responsibility to follow the policies and procedures established by the controller. This may be enforced by having the cost accountant report directly to the controller. In decentralized organizational structures, the same effect is sometimes accomplished by reserving to the controller the authority to approve in advance all appointments to key financial positions in the operating divisions and to require the removal of any incumbents whom he considers inadequate.

Fig. 1 shows the organizational pattern of a **single-plant company** in which the cost accountant reports to the controller. In **multiplant companies** the cost accounting work is usually done at the plant locations. Under these conditions some companies maintain the direct-reporting relationship of the cost accountant to the executive controller. Other companies have found it desirable to establish

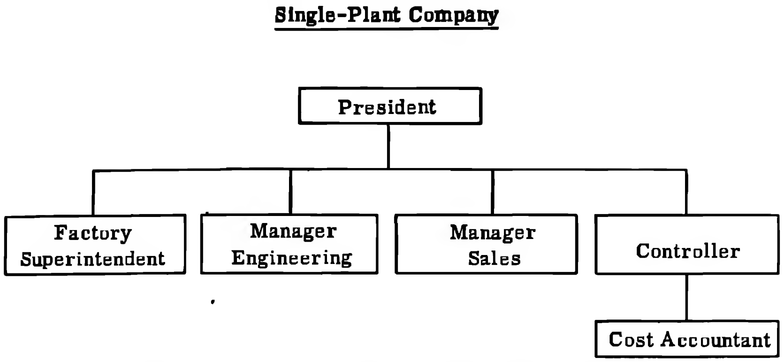


Fig. 1. Organization chart of single-plant company.

a **plant controller function** reporting for administrative purposes to the plant manager and responsible functionally to the company controller. This form of organization chart is shown in Fig. 2.

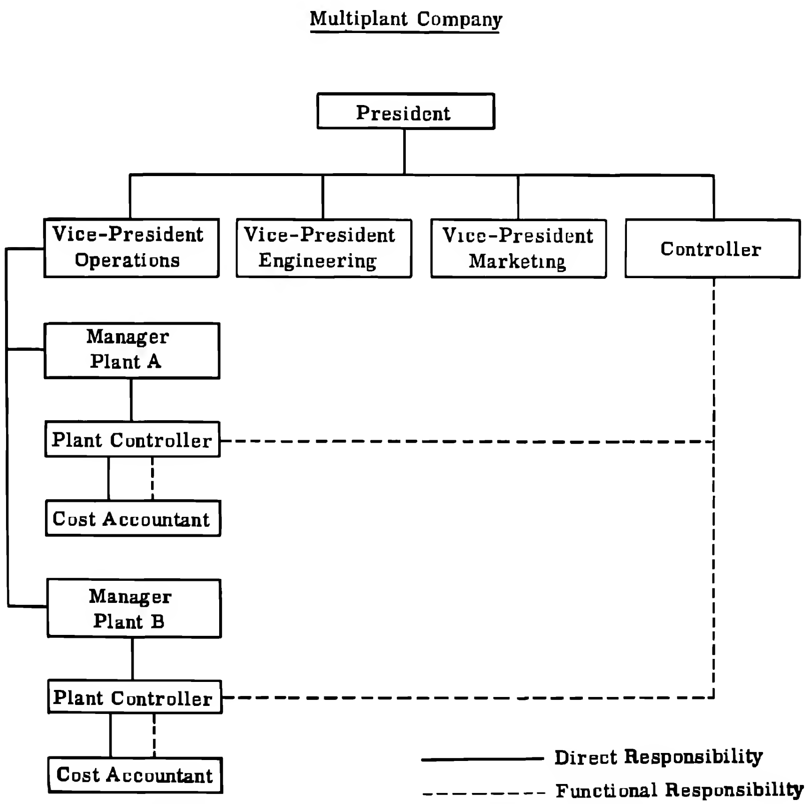


Fig. 2. Organization chart of multiplant company.

STRUCTURE OF THE COST ACCOUNTING DEPARTMENT. The purpose of designing departmental structure is to evolve a **plan for organizing** which is effective in meeting the objectives of the operation. The Controllership Foundation (Centralization vs. Decentralization in Organizing the Controller's Department) suggests the following criteria for testing the effectiveness of the controller's department:

1. Does it provide informational services of high quality?
2. Does it perform these services at a minimum cost?
3. Does it facilitate the long-range development of competent accounting and operating executives?

This research report indicates that in the companies studied, accounting information is used by management at various executive levels to answer three different kinds of questions: **Score-card** questions: Am I doing well or badly? **Attention-directing** questions: What problems should I look into? **Problem-solving** questions: Of the several ways of doing the job, which is the best?

The Controllership Foundation study states that, "there is generally much to be gained from separating, to a considerable degree within the controller's department, the personnel and units responsible for each of the three major kinds of functions," which are given as:

1. Bookkeeping and preparation and distribution of periodic accounting reports.
2. Assistance to the operating departments in current analyses of accounting information for score-card and attention-directing purposes.
3. Participation in the use of accounting information for problem solving on a special-studies basis.

In approaching the problem of organizing the cost accounting function, the following steps appear advisable: (1) Study the company organization structure and determine the management positions for which information service is to be provided and the type of service required; (2) identify and inventory the work to be performed; (3) group like kinds of work together; and (4) design each job to include sufficient work to challenge but not overtax the abilities of a normal, competent individual.

Centralized Operation. Heckert and Willson (Controllership) list five basic considerations which influence the decision as to the degree of **centralized accounting structure:**

1. The management philosophy as to divisional responsibility.
2. The availability of operating data.
3. The size of operating divisions or units.
4. The geographic location of the operating units.
5. The economies of the situation.

In a small company with only one plant or in a small plant, the cost accounting department would normally operate on a highly centralized basis. The clerical functions of **cost recording** and **routine reporting** would be combined under one supervisor, and specialists in **cost analysis** and **estimating** would work under the close supervision of the cost accounting manager, as shown in Fig. 3. Communication of information to management would be largely through the controller or the manager of cost accounting. The controller would delegate only a minor **amount** of decision-making responsibility.

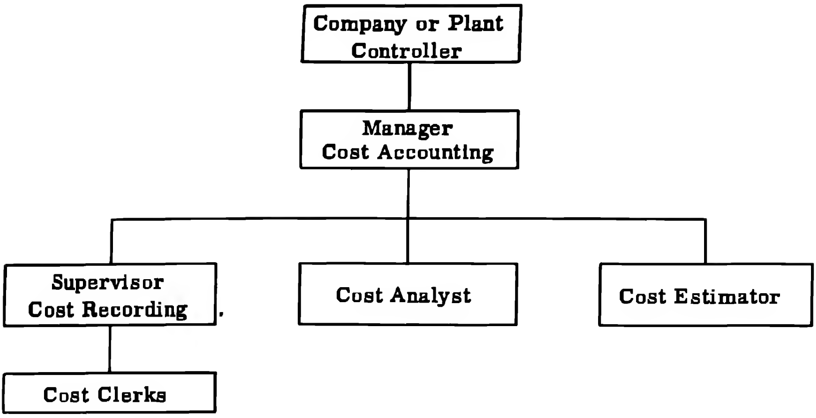


Fig. 3. Organization chart of cost accounting department in a small plant.

Some **advantages of a centralized organization** are given by Heckert and Willson (Controllership) as follows:

1. Permits greater flexibility in the utilization of existing personnel and facilities, including the abilty to meet peak loads.
2. Frequently permits the utilization of mechanical equipment that might not be justified in a decentralized situation.
3. May permit the utilization of more qualified personnel, particularly in the higher executive echelon, because of increased responsibilities.

However, the authors observe that the extent to which these advantages may not be realized in a decentralized organization depends in large part on the size of the local unit.

Decentralized Operation. A cost accounting department may decentralize its operations in several ways and in varying degrees. The Controllership Foundation research report (Centralization vs. Decentralization in Organizing the Controller's Department) gives five factors relating to the degree of **decentralization** of the controller's function:

1. The structure of the accounts and reports. A decentralized account structure is one that provides a maximum of information about individual subordinate organization units.
2. The geographical location of accounting functions. Geographical decentralization means locating the personnel of the controller's department in the company's factories and district offices rather than largely at the home office.
3. Formal authority relations. Decentralization of formal authority means attaching accounting units directly to the operating units whose activities they are recording.
4. Loyalties. Decentralization of loyalties means encouraging accounting personnel to regard themselves as members of the operating "team" to which they are providing service.
5. Channels of communication. Decentralization of communication means building up direct contact and communication between accounting personnel and the executives and supervisors of decentralized operating units.

Not all these factors have an effect upon the organizational structure. For example, it is possible to operate a decentralized structure of reports and accounts

from a central accounting point. This may be the first step taken in a company which is beginning to decentralize its operating functions. As the operations grow in size and complexity, it often becomes desirable because of communication problems or other factors to locate certain accounting personnel close to the managers of the operating components. The important move in cost accounting is to set up **cost analysts** to provide current analysis service to the local operating management and to serve in a liaison capacity between the central cost accounting organization and the operating component. The structuring of the cost accounting function in this pattern appears in Fig. 4.

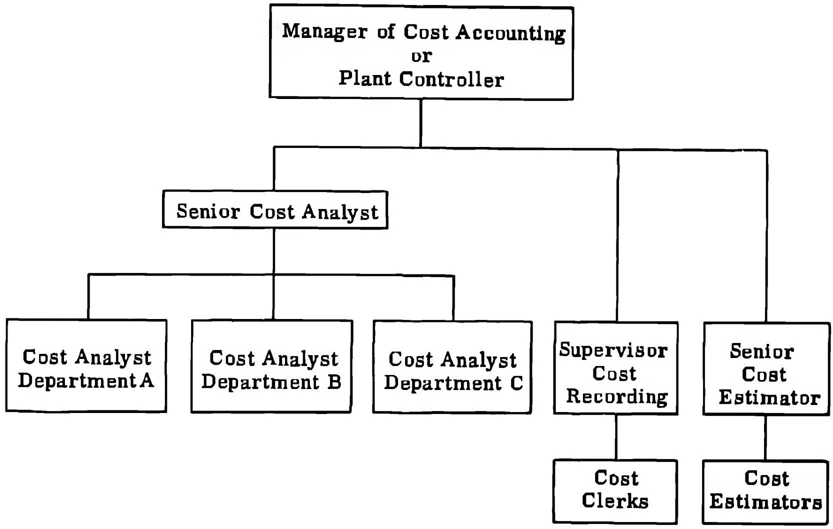


Fig. 4. Organization chart of cost accounting department in a large plant with centralized cost records.

Heckert and Willson (Controllership) emphasize the **advantages of decentralization** as follows:

1. From a psychological viewpoint, decentralization tends to increase the initiative of local management. The control responsibilities are more keenly felt.

2. Local origination of data avoids some excuses for inactivity or poor performance because "the report was too late," or "the report was wrong." This factor is partly psychological as to the benefits.

3. Duplication can be eliminated, particularly where the branch or plant also retains records so as to have current information or to "check up" on the home office report. Of course, if the [branch] records are maintained to have current data, this may be some indication that the wrong record was centralized.

4. Under ordinary circumstances, speedier results can be attained. When the entire operation is under local control, every effort will be made to secure timely data. This should contribute to closer cost control.

5. Wider accounting responsibility in the field is a means of training field personnel for promotions and generally results in a more sound organization.

6. Competent [branch] personnel can as readily prepare data for home office use as can the central organization. With an objective accountant on the job, perhaps even a better reporting of facts can be secured. Decentralization need not be a means

of denying the necessary data for executive control. For example, copies of the same reports going to divisional management could go also to home office management.

7. Decentralization is not in opposition to uniformity. It adds some flexibility and still permits the application of accounting policies and practices through the use of standard forms and standard practice manuals.

Heckert and Willson recognize, however, that decentralization is not always the best form of operation.

In some organizations the cost accounting **record-keeping function** is decentralized to parallel the operating departments. The principal purpose of this decentralized arrangement is to provide operating management with better access to records. In a single factory location, this may have only a small degree of

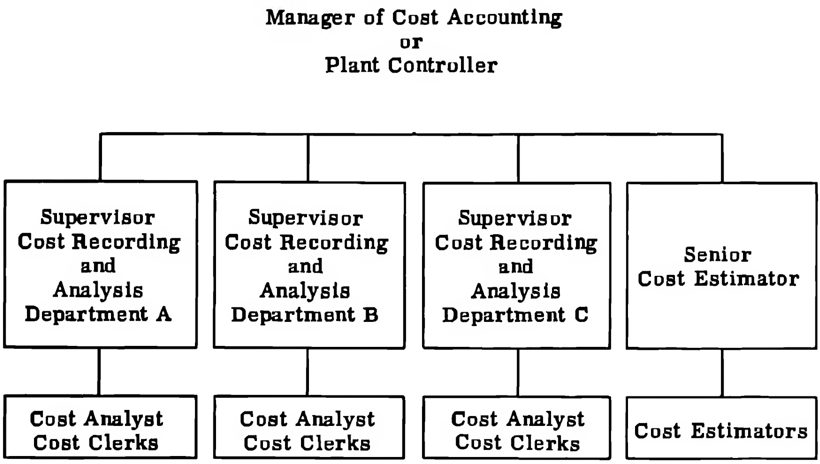


Fig. 5. Organization chart of cost accounting department in a large plant with decentralized cost records.

added value if the central records are well maintained and if the analysts are competent individuals. It is also usually found that the centralization of the record-keeping function results in a reduction in cost clerks or permits the application of **machine accounting methods**. Where this type of organizational structure is utilized, the decentralized cost units normally report to the manager of cost accounting or to the plant controller, as shown in Fig. 5, rather than to department superintendents or other operating personnel.

Departmental Personnel

PERSONNEL REQUIREMENTS. The personnel requirements of the cost accounting department include individuals of supervisory and administrative quality and also a group whose work is limited in scope to clerical activities. While it is necessary to maintain high standards in the selection of clerical people in order to assure a satisfactory level of efficiency, the caliber of the supervisory and administrative personnel (cost analysts, cost estimators, etc.) will largely determine the contribution made by the cost accounting department to the

operating management. The importance of the **personal qualities** of the accountant is emphasized by the team of experienced British accountants who visited American companies under the auspices of the Anglo-American Council on Productivity for a two-months' study of the relationship between accountants and management. In their report (Management Accounting) they wrote, ". . . to take no account of the personal factor in the preparation and use of figures is to overlook the determining factor in the effectiveness of the accounting branch of American companies."

Qualifications of Personnel. Many authors have set forth their ideas as to the qualities to be looked for in candidates for top accounting positions. Bastable (Controllership and People) says:

> In discussing the desirable attitudes and capacities of people worthy of development, the tendency is to enumerate a formidable list of qualifications, the fulfillment of which would tax a superman. Therefore, I would list four qualifications, each of which should be present in any individual considered for development: (1) ambition to succeed, (2) cooperativeness, (3) intellectual capacity, and (4) intellectual curiosity—perhaps whetted by a pinch of skepticism.

Intellectual capacity was defined by Bastable in terms of Knight's four qualities of an educated mind: (1) systematic, step-by-step reasoning, (2) the capacity to select the relevant and the significant from masses of detail, (3) ability to present findings clearly, and (4) the quality of imagination.

Keller (Management Accounting for Profit Control) has a more specific list of qualifications for accountants:

> To achieve the objective of management accounting, the personnel of the accounting department must (1) have an interest in, and knowledge of, all phases of the management and staff functions of the enterprise, (2) believe implicitly in a "profit and loss" economic system, (3) rate above average as persons, (4) recognize the need for constant revision and improvement in the management accounting process, and (5) be skilled in the art and science of accounting.

A discussion of some of the qualities important to cost accountants by Slade (NAA Bulletin, vol. 32) may be summarized as follows: (1) Be sufficiently versatile to comprehend and minister to the diverse needs of the several sections of the business in a practical manner. (2) Have good general knowledge of industrial accounting and costing techniques. (3) Have good mechanical shop knowledge. (4) Have insight into personal relations.

The characteristics and qualities enumerated by most writers are of value in guiding investigation of general personnel requirements. The problem of filling actual positions in the organization, however, requires a somewhat more specific approach. The starting point for determining the **specific personnel qualifications** required to fill a position in the cost accounting department is to prepare an outline of the responsibilities of the job to be filled. The second step is to write a **specification** for the educational background, previous experience or training required, and other particulars. For example, the requirements for a specialist's job such as that of cost estimator will weigh mechanical shop knowledge heavily, while the position of supervisor-cost recording will give more consideration to the individual's accounting knowledge and ability to direct the efforts of other people. This procedure enables the manager to have in mind when screening candidates a rather specific list of qualifications which are the most desirable and most likely to fit the job requirements.

Selection of Personnel. The problem of selecting the individual for the job is one of gaining as much knowledge as possible about each candidate. This is less difficult if the man is already employed in the organization and his on-the-job capabilities have been regularly appraised. In hiring new employees, it is necessary to rely upon a personal interview, recommendations of previous employers, aptitude tests, psychological tests, and similar techniques. The problem of selecting men for a financial training program in one of the larger companies is described by MacKinnon (NAA Bulletin, vol. 34): "Although the characteristics required for success may be fully known, there still remains the problem of determining in a very brief period whether each prospect has these characteristics or does not have them." MacKinnon notes several ways in which candidates can be **appraised** and the appraisal checked:

1. Personal interview.
2. Academic record.
3. Record of extra-curricular activities.
4. Record of work experience.
5. Personal recommendations of college placement officer, professors, and former employers.

MacKinnon stresses the importance of the skill and judgment of the interviewer in the final determination. Although heavy weight is given to academic standing, it is indicated that consideration needs to be given to the effect on grades of extra-curricular activities, part-time employment, academic standards of the school, and relative standing of the individual in his class.

PERSONNEL DEVELOPMENT. The type of personnel development program undertaken should be determined by the needs of the business. There are at least two basic objectives of a development program: (1) to enable the individual to do a better job on his present assignment, and (2) to train and broaden the individual for a more responsible position.

Gove (NAA Bulletin, vol. 36) outlines a program having as its primary objective a better cost accounting operation, with the promotion of individuals as a by-product. The elements of this program are to:

1. Provide a favorable climate for self-development.
2. Tie in with a company-wide program if available.
3. Train new employees.
4. Provide opportunity for extensive contacts with other segments of the organization.
5. Offer job rotation.
6. Take advantage of special assignments.

One of the important features of this program is the establishment of a favorable climate through demonstrating the interest of supervision in encouraging, aiding, and counseling employees in pursuing a **self-development program.** This requires that supervisors take time for discussion of the employee's progress, suggest reading material, pass on information relating to operations of the company, and participate in other ways in the educational process.

Most personnel development programs include **appraisal of the individual** as a part of the plan. As expressed by Schauer (Controller, vol. 25), "any plan for improvement of job performance must include several simple practical steps." Schauer lists these steps as:

1. Set up standards of performance.
2. Measure or judge performance against such standards.
3. Counsel with the employee and plan a program for improvement.

Schauer recognizes that setting up standards of performance is easier said than done, but he suggests that written job descriptions are a step in the direction of an objective standard. Measuring employee performance involves a judgment or appraisal which is then communicated to the employee at the same time that plans for improvement and future training are discussed. A sample **appraisal form** accompanying Schauer's presentation includes the following:

1. Check list of behavior samples. This included forty specific items such as
   —"Has taken over the work of fellow workers at a critical time and handled it well."
   —"Has been lacking in tact in telephone conversations."
2. Appraisal of performance on the job.
   (a) Knowledge of job.
   (b) Quality of work.
   (c) Quantity of work.
   (d) Work habits and attitudes.
   (e) Ability to plan and organize work.
   (f) Responsiveness to change.
   (g) Ability as a teacher.
3. Appraisal of personal qualities.
   (a) Physical condition.
   (b) Ability to get along with others.
   (c) Ability to plan and inspire activity of others.
   (d) Judgment and common sense.
   (e) Ability to learn.
   (f) Power of analysis.
   (g) Power of expression.
   (h) Initiative.
4. Two basic questions.
   —What is this person doing well?
   —What can this person do to improve?
5. Space to record date on which the appraisal was discussed with employee and the results of discussion.

Where emphasis is being placed on promotion, personnel development programs become somewhat broader in scope. Hagaman (Controllership and People) advocates a program that includes: (1) long-range planning of organizational structure; (2) personnel inventory, including present incumbent and planned replacement for each key job; (3) periodic appraisal of job performance and potential ability of each person on the replacement table; and (4) program of individual development for each person.

With respect to **methods of personnel development,** Hagaman says:

> The list of methods to be used in a development plan could be almost limitless. In our view, most of them involve development at the work place and in the work situation. There are a number of other methods which are of great importance because they contribute largely to a person's background and his own individual development. However, unless they are translated into conscious action in the day-to-day rush of activities, these other methods don't contribute very much.

He enumerates specific methods as follows:

> Within the realm of job performance, personnel development methods include: (1) organizational changes or transfers, (2) job rotation, (3) special assignments, (4) acting in superior's absence, (5) committee assignments, and (6) acting as chairman of task force on special problems.
>
> Other methods include: (1) after-hours educational classwork, (2) management schools and programs, (3) attendance at meetings or seminars, (4) public speaking

engagements, (5) instructorship in training program, (6) acting as chairman of meetings, (7) developmental reading, (8) observational visits, (9) professional society activities, and (10) community activities.

Powlison (Controllership in Modern Management, Bradshaw and Hull, eds.) emphasizes the importance of putting the potentially good men in supervisory positions as early as possible and then watching them and aiding the development of their social skills. He comments: "The most serious of all personnel problems, as I see it, are those which concern individuals who have been permitted to reach maturity in their own personal development and fairly high salary brackets before they learn to supervise others."

It may be concluded that the operation of a successful and effective cost accounting department will depend to a large extent upon the people in the organization. The two elements of selection and development of personnel are the basis for continuance of high-quality performance. This program should, in the long run, include provision for (1) careful selection of employees, (2) opportunity for self-development, (3) appraisal of on-the-job performance together with counseling of the employee, and (4) promotion to assignments of increased responsibility in accordance with the demonstrated capabilities of the individual.

SECTION 5

MATERIALS

CONTENTS

CONTENTS (*Continued*)

SECTION 5

MATERIALS

Functions of Materials Accounting

BASIC OBJECTIVES. In Fig. 1, Vance (Theory and Technique of Cost Accounting) gives an over-all view of the documents, records, and accounting procedures used in the acquisition and processing of material and the shipping of finished product. This section is concerned primarily with the cost accounting aspects of materials. [Related topics are discussed in detail in the sections on Inventories and Purchasing in the Accountants' Handbook (Wixon, ed.).]

If accounting processes, procedures, forms, and reports related to the acquisition, storage, and utilization of materials are to be effectively formulated, they need to be oriented to the following basic objectives:

1. **Physical control.** Through carefully designed forms, procedures, and reports, accounting serves management by furnishing information needed to fulfill the responsibility of providing for the physical protection of investments in materials and supplies.
2. **Managerial decision making.** It is the responsibility of management to plan production and related material acquisitions so that the right kind of materials will be available at the right place at the time they are needed. This is to be accomplished while at the same time avoiding over-investment in materials. The invoice cost of materials is only one element of total material costs. Other costs are those related to acquisition, handling, and storage. The objective of maximizing profits requires the determination of the most economical quantity in which purchases of a given material are to be made. Information of this type needed by management for decision-making purposes should be made available through regular and special reports prepared by the cost accounting department.
3. **Financial statements.** Periodic income statements and balance sheets are important products of accounting efforts. Material costs have relevance to each of these statements. Accounting procedures related to accounting for materials should be formulated so as to facilitate preparation of these statements.

MATERIAL COSTS UTILIZED. For **income determination** purposes, it is necessary to determine the cost of those materials incorporated or used in producing units sold. There is also the need to ascertain the cost of those materials written off during the period because of obsolescence, or physical damage, or deterioration.

For **balance sheet** purposes, cost of materials acquired and not yet placed in production is needed for raw materials inventory. The cost of materials in process is included as a part of the cost of work in process. The material cost element included in unsold finished products is needed for presentation as part of the cost of Finished Goods Inventory. All of these are included among the current assets.

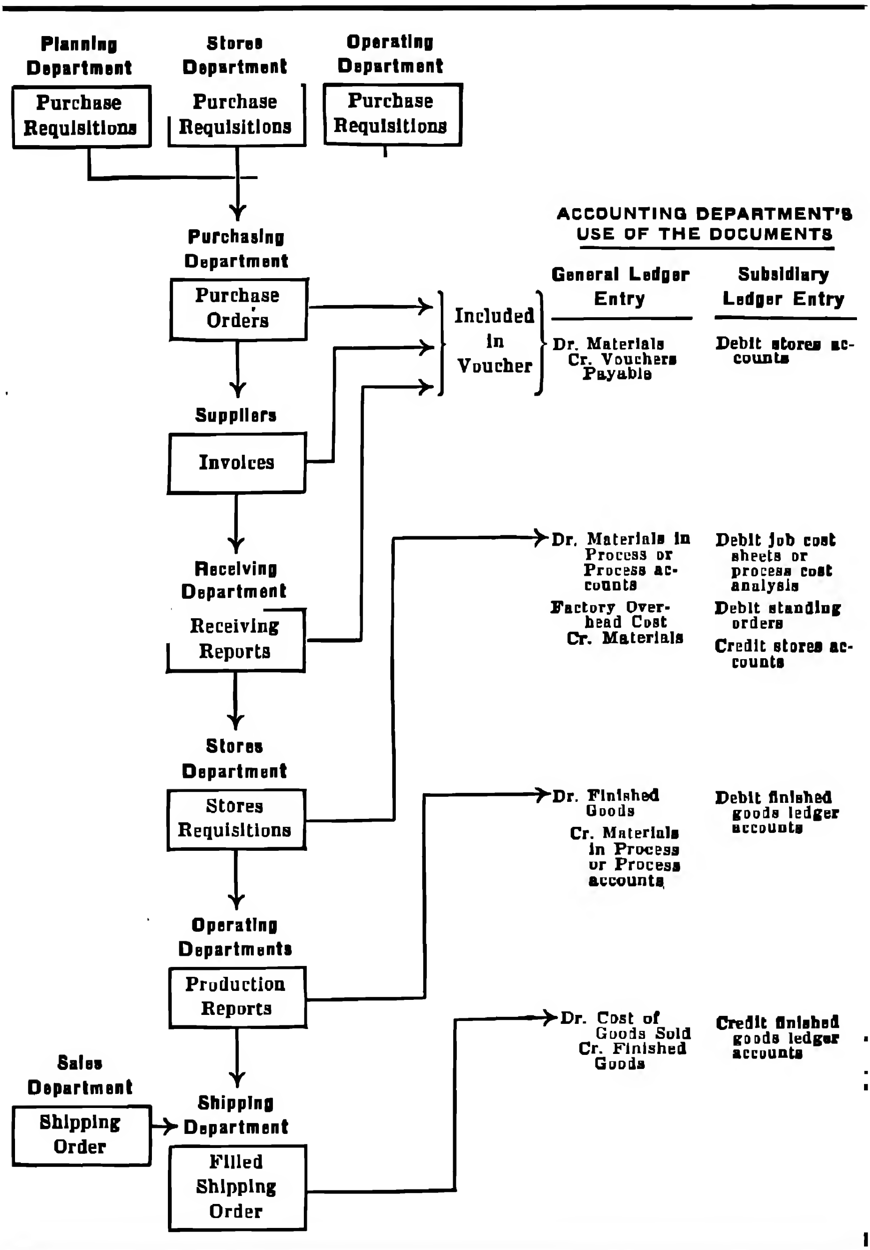


Fig. 1. Steps and documents involved in the acquisition and processing of materials and shipment of product.

Physical Control

NEED FOR CONTROL. Physical control of inventories is usually not a part of the accountant's functions. Heckert and Willson (Controllership, the Work of the Accounting Executive) state:

> Operating control of raw material and supply inventories generally rests with either the factory management or the purchasing department. Where supply factors or market conditions are predominant factors instead of production requirements, the purchasing department is likely to be governing. In other instances where production is for stock, then the production-planning executive may be responsible.

In order to make physical control effective, however, there is need for adequate **inventory records,** test checks of physical quantities, and inventory reports. These ordinarily fall within the area of accounting responsibilities.

For many enterprises the investment in materials and supplies represents a very significant part of their total current assets. In some of these inventories are found materials and supplies which are about as easily misappropriated and perhaps about as much desired by some employees as cash. A manufacturer of jewelry, for example, necessarily carries some high-value gems and metals in stock. A producer or user of electronic parts having in stock some parts that are usable in the manufacture of high-fidelity sound equipment may have personnel on the payroll who assemble or repair high-fidelity equipment as a hobby. Under such conditions it is desirable to provide for the physical control of these assets.

CONDITIONS ESSENTIAL TO EFFECTIVE PHYSICAL CONTROL. There are several conditions which are essential if there is to be effective physical control of materials.

Designated Areas of Responsibility. It is necessary that the organization of the stores department provide for well-defined areas of responsibility. Bliss (NAA Bulletin, vol. 32) states that: "It is necessary to centralize the authority for controlling inventories, wherever practical, at one level of management and to one person. In addition, responsibility for each inventory location must be assigned to one individual, making certain that there is no overlapping of responsibility or authority."

Suitable Storage Facilities. A second condition necessary for effective physical control is adequate storage facilities. The **degree of protection** required will depend upon the type of material to be protected. Those of relatively great value that have many alternative uses and which are small enough to be easily concealed require a high degree of protection. A screened-in area should be provided for the safekeeping of such materials. Only the custodians should have access to this storeroom. Issues of this type of material will usually be made over the counter on the basis of duly authorized requisitions. Adequate storage facilities for bulkier items may consist of large storage areas such as warehouses with access limited to one entrance, at which point the custodian exercises his control functions.

Orderly Storage Arrangement. In each storage facility it is desirable that there be a systematic storage arrangement. It is easier to take a physical inventory when items are stored in an orderly manner. Test checks may be made with a minimum of effort and may be undertaken more frequently. Storeroom personnel are likely to feel a greater degree of responsibility for their actions because

they know that discrepancies almost certainly will be detected and explanations required.

Adequate Accounting Records. Physical control is facilitated by the presence of a dependable set of accounting records. Accountability presupposes that there is information with respect to the quantities of materials for which each custodian is accountable. Keller (Management Accounting for Profit Control) states:

> The records must show quantities entering, on hand in, and leaving each storeroom or operation. Then when shortages occur, it is possible to concentrate vigilance on a small area and thus detect the cause quickly. The very fact that a good system of control through records is in operation will provide a strong psychological deterrent to individuals who, otherwise may be tempted to carry some of the products away. It is a major link in the chain of internal control procedure.

As in accounting for cash, it is desirable that accounting recognition be given to materials as these are received. Accountability is thereby immediately established. Accounting entries should reflect movements of materials as they occur. The **receiving report** constitutes the initial recognition of accountability. A **materials movement report** may be used to reflect movement from the receiving area to the storage area. This has the effect of shifting the accountability from the individual who originally received the materials to the custodian responsible for the materials being placed in his storage facility. As these materials are withdrawn from this general storage area and moved to storage facilities in the factory, **material transfer reports** reflect the transfer of accountability from the custodian of the general storage area to the individual custodians of the various storerooms in the factory.

Definite Designation. Every item of material handled should have a definite name and should always be dealt with under that name. In storing, every lot, unit, or article should be marked or labeled so that it can be identified easily in the storeroom. In addition to the identification of the goods themselves, there should be a **plan of identification** carried out in all parts of the storeroom by the following methods:

1. The storeroom should be sectionalized, and only goods of one particular class stored in each section. In order to identify the sections, signs should be suspended from the ceiling in each section, or otherwise located, so as to indicate the general type of goods stored in that section.
2. Signs or bin tags should be attached to bins, racks, pans, and shelves to indicate the particular materials stored therein.
3. A general storage plan should be posted in a convenient location which may be used as a guide by those unfamiliar with the location of materials within the storeroom.
4. Finding lists should be prepared showing the various sections, aisles, and storage spaces of the storeroom and the class of goods stored in each.

Use of Code. Even though each item has a definite name assigned to it, it may be desirable also to assign a code or symbol designation to each item. The use of symbols may make it unnecessary in many situations to write out the full name of the item being recorded, the **symbol designation** alone being sufficient identification. The use of symbols rather than lengthy name designations fosters accuracy in identification of materials because there is less temptation to use abbreviated symbol designations or otherwise accept something less than the assigned designations. The use of symbols rather than complete names of parts

is better suited to machine accounting because less space is required to identify each item of material, thus freeing spaces on machine cards and forms for other desired information. (For discussion of machine accounting see section on Basic Cost Records.) The development and use of a suitable system of symbols contributes much to the efficient handling of, and accounting for, stores. NAA Research Series No. 34 (Classification and Coding Techniques to Facilitate Accounting Operations) observes that:

> . . . growth in the volume and variety of materials used has, in many companies, called for improved managerial control over costs of materials and also over costs of paperwork relating thereto. Classification and coding are essential steps in establishing and maintaining this control.

FREE ACCESS MATERIALS. Decisions regarding the accounting procedures to be employed as well as physical protection to be provided for the various types of inventory items should be made after giving appropriate consideration to such factors as the value of the items, volume used, and risk of loss. Many firms have found it advisable to place an adequate supply of low value, high volume items in shop areas where they are to be used, thereby reducing the need for employee trips to stock issue rooms. Clark (NAA Bulletin, vol. 39) states:

> Almost every company and every department of each company will have a great number of items that are readily available to employees without a signed requisition. For example, the company garage may have such items as cotter pins, rivets, screws, washers, valve caps, lock washers, greases, etc. These items have all been charged out to expense at the time of recording the vendor's invoice.

Clark describes another free access material procedure used by the Portland General Electric Company. This inventory category is called **truck stock.**

> The stock consists of connectors, fuses, service wire, service knobs, some guy wire, a few cross-arms, and all the miscellaneous accretions made by the line foreman or rig driver. The truck stock is replenished by requisitions on storeroom stock from time to time, and such replenishments are charged to the accounts appropriate for the use as reported by the foreman.

The foregoing description illustrates some modifications and adaptations of usual procedures in order to achieve efficiency in operations and economy in record keeping. The justification is to be found in the over-all reduction in cost to the company.

SYMBOLIZATION AND CLASSIFICATION PROCEDURE. The process of symbolization and classification involves two steps:

1. Determine the number of items and the nature of each.
2. Group similar items into "classes" and assign names to these classes. Similar classes may be further combined into more inclusive classes with appropriate descriptive designators.

SYSTEMS OF STORES SYMBOLIZATION. Various schemes of symbolization are used in industry. (The use of code systems on accounts is discussed in detail in the section on Cost Classification.) The more common code systems used for stores are discussed in subsequent paragraphs.

Alphabetic System. In an alphabetic or letter code system, letters are chosen to represent particular classifications. Since the alphabet consists of 26 letters, each position in the code has 26 possible letters as compared with ten possibilities

for any one position under a numerical system. This feature makes possible a coding system in which fewer places or positions are required.

Where relatively few classifications are involved, assignment of letter designators is sometimes arbitrarily made. Assignments are made haphazardly rather than in a manner which will facilitate memorization.

Mnemonic System. The mnemonic code system is basically an alphabetic system but one in which code designators are assigned with the objective of easy memorization. For example, MS may be used to designate machine screws. Additional letters can be used to suggest types of materials. MSC may indicate machine screws—copper; MSB, machine screws—brass; MSS, machine screws—stainless steel, etc.

Mnemonic code designators may also be assigned to aid in associating parts with a given product. For example, EF may be a part of each code designator related to a type of electric fan being manufactured. If large and small sizes are being produced, this distinction can be accomplished by adding L or S to the EF code. The letter A may be used to identify armatures; B, bearings; S, switch control; etc.

Code	Description
EFLS	Electric fan, large, switch
EFSB	Electric fan, small, bearings
EFLA	Electric fan, large, armature

Simple Numeric or Sequence System. Under this code system, numbers are assigned to classifications as need arises. With regard to assignment of numerical code designations to materials, each time a new type of material is acquired, the next higher number in the sequence is assigned to it. Under this system one may find, for example, the following list of numbers with related parts as described:

Code Number	Part Description
101	¼″ machine screw, 1″ long
102	⅛″ machine screw, 1″ long
103	4′ × 8′ × ¼″ steel plate
104	⅜″ machine screw, 1″ long
105	½″ × 10′ galvanized pipe

The obvious disadvantage of this simple numerical sequence is that there are no memory aids incorporated in the system. Under such a system individuals recording code numbers on purchase requisitions, purchase orders, receiving reports, and materials requisitions slips spend much time searching for code numbers in **material code books.**

Numeric System. Under this coding system, sometimes called the **group** system, the first or basic numbers indicate specific classes, with subsequent digits used to describe subclassifications. For example, the basic digits for machine bolts may be 36. The next two digits can be used to designate the diameter. Additional numbers can be added to indicate length.

Code Number	Part Description
36181	Machine bolt, ⅛″ diam., 1″ long
363815	Machine bolt, ⅜″ diam., 1½″ long
36782	Machine bolt, ⅞″ diam., 2″ long

If the user of the code can remember that the basic digits "36" designate machine bolts, the remainder of the code number is easily remembered because they are dimensions.

Decimal System. Enterprises using this system usually assign numbers in such a manner that each digit represents a subgroup or subaccount of the previous digit. For example, an automobile manufacturer may assign the number "16" to an assembled wheel. The following code numbers may be used to designate component parts:

Code Number	Part Description
16.1	Tire
16.11	Valve stem
16.111	Valve
16.112	Valve cap
16.2	Brake drum
16.3	Nuts
16.4	Disc
16.51	Inner bearing
16.52	Outer bearing

The principal advantage of a decimal system is its capacity to expand to accommodate new items. Its primary disadvantage is that it may become cumbersome when a basic unit has many major subassemblies consisting of many minor assemblies which in turn consist of numerous subassemblies.

Block System. Blocks of numbers are reserved for specified classifications. For example, in the materials category for stock ledger purposes, 7500–7549 may be assigned to basic raw materials, 7550–7599 to manufacturing supplies, 7600–7999 to manufactured parts, etc. **Unassigned numbers** should be provided to accommodate subsequent expansion.

Combination Systems. Some firms have found it advantageous to combine a mnemonic and numerical or decimal system. Thus a manufacturer using various grades and thicknesses of plywood may use the following code:

Code Number	Description
PW 181	Plywood, ⅛″ thick, 1st grade
PW 142	Plywood, ¼″ thick, 2nd grade
PW 381	Plywood, ⅜″ thick, 1st grade

A MATERIAL AND EQUIPMENT CLASSIFICATION. The Detroit Edison classification of materials and equipment is arranged so that items of a similar nature are automatically brought together into groups of related items. For example, all tools, regardless of the department using them or of the particular equipment for which they are designed, are placed in two classes (one class for hand tools and the second class for power tools) and all wire and cable in one class. There are 68 main groups or **classes** which, in turn, are divided into 350 **subclasses**. To illustrate, packing and gaskets of all kinds are grouped together into Class 56, entitled Packing and Gaskets, which is organized in four subclasses:

56–0 Rod, shaft, and valve-stem packing.
56–1 Sheet packing.
56–2 Gaskets.
56–3 Miscellaneous packing.

The arrangement of the items according to the department by which they are used was not attempted, so there is no group which brings together all the items used by a particular department. Likewise, the arrangement of the items according to the use which is made of them was not attempted, so there is no group for

all the items used, as, for example, in substation construction work. Both these arrangements, by department and by use, were considered and eliminated by the company's standards committee. The arrangement of the items in the Standards Catalog according to their nature brings together items which are similar, and such an arrangement facilitates standardization. Furthermore, the arrangement eliminates the duplicate listing of items, which is unavoidable in a classification based upon departmental responsibility or upon the use to which items are put. The arrangement adopted makes it relatively easy to find an item for which search is being made. However, there is added to this Catalog an index of items arranged alphabetically for the convenience of those desiring to use the alphabetical method of finding an item for which they are looking.

It is a general principle of the classification that parts are listed with the assemblies to which they belong. Thus an oil-switch tank is placed with the oil switch to which it belongs and is not placed with a miscellaneous collection of other tanks. An exception is made for appliance repair parts, which are in special subgroups of their own instead of being listed under the appliances to which they belong.

Each item in the Standards Catalog bears an Edison number of seven digits. The first two digits indicate the main class in which the item belongs, the third digit designates the subclass, and the last four digits constitute a serial number. Thus the number 543–0236 means that the item belongs in main Class 54 Valves, Subclass 3 Globe Valves and has been assigned the serial number 0236. Spare parts generally bear a serial number commencing with eight or nine. Thus, a spare part for an Air Heater (which is classified in Class 49, Subclass 3) might be numbered 493–8134 or 493–9075. An exception to this general rule occurs in Class 0 Appliances, in that repair parts are in separate subclasses from complete appliances.

The complete classification is given in the accompanying table.

Classification of Material and Equipment

APPLIANCES

0.† Appliances
- 00 Appliance Parts
- 001 Range Parts
- 002 Water Heater Parts
- 003 Refrigerator Parts
- 004†
- 005 Iron Parts
- 006 Coffee Maker, Percolator and Teakettle Parts
- 007 Toaster Parts
- 008 Clock, Mixer, and Roaster Parts
- 009 Miscellaneous Parts

Electrical Appliances
- 014 Clocks
- 016 Coffee Makers and Percolators
- 018 Cookers and Hotplates, Griddles, Grills, Roasters, Casseroles
- 022 Farm Equipment
- 026 Food Mixers
- 028 Freezers, Home or Deep
- 032 Heaters, Water
- 036 Irons, Household, Tailor and Travel
- 040 Irons, Waffle
- 044 Ironing Machine
- 054 Ranges, New
- 055 Ranges, Used
- 056 Range Accessories
- 058 Refrigerators
- 062 Teakettles
- 066 Toasters
- 071 Misc. Cleaners, Vacuum and Attachments
- 072 Conditioners, Air
- 074 Dryers, Clothes
- 076 Fans
- 080 Heaters, Space
- 081 Heating Pads

† Unassigned subclasses, e.g., 004, 010, 011, 012, 013, etc., are reserved for possible expansion.

Classification of Material and Equipment (Cont'd.)

082 Kitchen Equipment, Cabinets, Dishwashers, Disposal and Sinks
083 Lamps, Bulb, Floor, Health, Heat, Range, Reading
084 Electric Bed Coverings
085 Radio and Television
086 Timers, All Kinds
088 Washing Machines
089 Miscellaneous Electrical Appliances

BUILDING MATERIALS

10 Masonry and Concrete Material
- 10–0 Cinders, Gravel, Sand, Crushed Stone, etc.
- 10–1 Lime, Plaster, and Cements
- 10–2 Brick, Terra Cotta, Vitrified Sewer Pipe, Tile, etc.
- 10–9 Miscellaneous Masonry and Concrete Material

11 Cut and Artificial Stone
- 11–0 Marble
- 11–1 Slate
- 11–2 Granite
- 11–3 Alberene
- 11–4 Artificial Stone
- 11–9 Miscellaneous Stone

12‡

13 Lumber
- 13–0 Yard Lumber
- 13–1 Millwork
- 13–2 Timbers
- 13–9 Miscellaneous Lumber

14 Poles, Crossarms, and Other Wood Line Material
- 14–0 Poles
- 14–1 Crossarms
- 14–2 Other Wood Line Material

15 Building Insulation and Lumber Substitutes
- 15–0 Panel, Plaster, and Wall Board
- 15–1 Building and Roofing Papers
- 15–2 Composition Shingles, etc.
- 15–9 Miscellaneous Building Insulation and Lumber Substitutes

16 Paints and Similar Protective Coatings
- 16–0 Enamels, Paints, and Synthetics
- 16–1 Pigments
- 16–2 Lacquer
- 16–3 Stains and Sealers
- 16–4 Fillers
- 16–5 Vehicles (Oils, Thinners, Driers, etc.)
- 16–6 Shellac and Varnish
- 16–9 Miscellaneous Paints and Similar Protective Coatings

17‡

18 Glass and Glazing Material
- 18–0 Clear Sheet (Window) Glass
- 18–1 Polished Plate Glass
- 18–2 Obscure (Rough) Glass
- 18–3 Wire Glass
- 18–4 Glass Mirrors
- 18–5 Glazing Material
- 18–9 Miscellaneous Glass

19‡

HARDWARE

20 Builders' Hardware
- 20–0 Bars, Plates, and Rods
- 20–1 Braces and Brackets
- 20–2 Hooks and Holders
- 20–3 Knobs, Handles, and Pulls
- 20–4 Bolts, Catches, and Latches
- 20–5 Locks and Padlocks
- 20–6 Door Checks, Springs, and Stops
- 20–7 Hinges and Door Hangers
- 20–9 Miscellaneous Builders' Hardware

21†

22, 23 General Hardware
- 22–0 Abrasives
- 22–1 Carts, Wagons, Wheelbarrows, Push Trucks, etc.
- 22–2 Furniture Shoes, Casters, Cart Wheels, etc.
- 22–3 Buckets, Cans, Containers, Funnels, Kettles, Measures, Pails, Pans, Pots, etc.
- 22–4 Fencing
- 22–5 Hose and Hose Fittings
- 22–6 Ladders, Staging, Scaffolds, etc.
- 22–7 Lanterns, Flashlights, and Torches
- 22–8 Lubricating Equipment
- 23–0 Welding and Soldering Equipment

‡ Class numbers reserved for possible expansion of the classification.

Classification of Material and Equipment (Cont'd.)

- 23–1 Clamps, Hangers, and Straps
- 23–2 Fittings for Wire Rope and Chain
- 23–3 Springs
- 23–4 Adhesives
- 23–9 Miscellaneous General Hardware

24 Line Hardware
- 24–0 Distribution Y-Network } Alphabetical Arrangement

25 Fasteners
- 25–0 Anchors, Inserts, etc.
- 25–1 Bolts (Including Studs)
- 25–2 Nuts
- 25–3 Cotters, Washers, etc.
- 25–4 Brads, Nails, Spikes, etc.
- 25–5 Screws, Screw Eyes and Screw Hooks
- 25–6 Rivets
- 25–9 Miscellaneous Fasteners

26†

27 Hand Tools
- 27–0 (Alphabetical Arrangement)

28 Power Tools
- 28–0 (Alphabetical Arrangement)

29†

Metals

30 Iron and Steel
- 30–0 Shapes
- 30–1 Concrete Reinforcing Steel and Accessories
- 30–2 Iron and Steel Wire
- 30–3 Bands, Bars, Plates, Sheets, etc.
- 30–5 Structural Steel for Transmission Line Poles, Towers, and Outdoor Substations
- 30–9 Miscellaneous Iron and Steel

31†

32 Nonferrous Metals
- 32–0 Aluminum
- 32–1 Brass
- 32–2 Bronze
- 32–3 Copper
- 32–4 Lead
- 32–9 Miscellaneous Metals (Monel, Nickel, Solder, Zinc, etc.)

33 Castings
- 33–0 Aluminum Castings
- 33–1 Brass Castings
- 33–2 Bronze Castings
- 33–3 Copper Castings
- 33–4 Iron Castings
- 33–5 Steel Castings
- 33–9 Miscellaneous Castings

34†

Mechanical Equipment

35 Building Service Equipment
- 35–0 Building Heating Equipment
- 35–1 Refuse Burners
- 35–2 Refrigerating Equipment
- 35–3 Water Coolers
- 35–9 Miscellaneous Building Service Equipment

36 Chain, Rope, Cord, etc.
- 36–0 Chain
- 36–1 Wire Rope
- 36–2 Fiber and Synthetic Rope
- 36–3 Cord, Twine, String, etc.
- 36–9 Miscellaneous Chain and Rope

37†

38 Hoisting Machinery and Equipment
- 38–0 Platform Elevators
- 38–1 Cranes
- 38–2 Hand Hoists
- 38–3 Power Hoists
- 38–4 Hoisting Equipment
- 38–9 Miscellaneous Hoisting Machinery

39 Mechanical Power Transmission Equipment
- 39–0 Belting and Accessories
- 39–1 Pulleys
- 39–2 Bearings, Bushings, Boxes, Hangers, etc.
- 39–3 Clutches, Collars and Couplings
- 39–4 Drives, Drive Chains and Sprockets
- 39–5 Gears
- 39–9 Miscellaneous Mechanical Power Transmission Equipment

40†

41 Conveying and Trenching Machinery and Equipment
- 41–0 Gravity Conveyors
- 41–1 Continuous Conveyors
- 41–2 Jet and Pneumatic Conveyors
- 41–3 Miscellaneous Conveyors
- 41–4 Conveyor Equipment
- 41–5 Trenching Machinery and Equipment

42 Special Purpose Machinery
- 42–0 Bagging Machines

Classification of Material and Equipment (Cont'd.)

43 Stokers, Burners, and Coal Preparation Equipment
- 43–0 Burners
- 43–1 Stokers
- 43–2 Coal Breakers, Crushers, Pulverizers, etc.

44 Boilers, Economizers, Superheaters, and Air Preheaters
- 44–0 Boilers
- 44–1 Economizers
- 44–2 Superheaters
- 44–3 Air Preheaters

45 Prime Movers (Including Connected Generators)
- 45–0 Turbo-generator Units
- 45–1 Turbines
- 45–2 Steam Engines
- 45–3 Internal Combustion Engines
- 45–4 Water Wheels

46 Condensers, Evaporators, Heaters, and Water Purifiers
- 46–0 Condensers
- 46–1 Evaporators
- 46–2 Water Heaters
- 46–3 Water Purifiers

47 Pumps and Compressors
- 47–0 Pumps
- 47–1 Air and Gas Compressors

48‡

49 Air and Flue Gas Cleaning and Handling Apparatus
- 49–0 Air Filters and Supplies
- 49–1 Air Washers, Coolers, and Humidifiers
- 49–2 Fans
- 49–3 Air Heaters
- 49–4 Dust Collectors, Precipitators, etc.
- 49–9 Miscellaneous Air and Flue Gas Apparatus

50 Oil Separators, Reclaimers, Coolers, etc.
- 50–0 Oil Separators
- 50–1 Oil Reclaimers and Purifiers
- 50–2 Oil Filters
- 50–3 Oil Coolers
- 50–4 Oil Apparatus Accessories
- 50–9 Miscellaneous Oil Apparatus

51 Pipe and Tubing
- 51–0 Steel Pipe and Tubing
- 51–1 Wrought Iron Pipe
- 51–2 Cast Iron Pipe
- 51–3 Copper Pipe and Tubing
- 51–4 Brass Pipe and Tubing
- 51–5 Lead Pipe and Tubing
- 51–6 Aluminum Pipe and Tubing
- 51–9 Miscellaneous Pipe and Tubing

52 Pipe Fittings
- 52–0 Pressure Fittings
- 52–1 Drainage Fittings
- 52–2 Soil Pipe Fittings
- 52–3 Railing Fittings
- 52–4 Pipe Frame Fittings

53‡

54 Valves
- 54–0 Angle Valves
- 54–1 Check Valves
- 54–2 Gate Valves
- 54–3 Globe Valves
- 54–4 Safety or Relief Valves
- 54–5 Float, Foot, and Regulating Valves
- 54–6 Cocks (Plug Valves)
- 54–9 Miscellaneous Valves

55 Piping Specialties and Plumbing Fixtures
- 55–0 (Alphabetical Arrangement)

56 Packing and Gaskets
- 56–0 Rod, Shaft, and Valve Stem Packing
- 56–1 Sheet Packing
- 56–2 Gaskets
- 56–9 Miscellaneous

57‡

58 Heat Insulation
- 58–4 Insulating Cements
- 58–5 Pipe Insulation
- 58–6 Block Insulation
- 58–9 Miscellaneous Heat Insulation

59 Refractories
- 59–0 Fire Brick
- 59–1 Fire Clay Fillers
- 59–2 Refractory Cements
- 59–9 Miscellaneous Refractories

Control Apparatus and Measuring Instruments

60 Mechanical Control Apparatus
- 60–0 Temperature Controls
- 60–1 Pressure Controls
- 60–2 Volume Controls
- 60–3 Speed Controls
- 60–9 Miscellaneous Mechanical Control Apparatus

61 Mechanical Measuring Instruments
- 61–0 Temperature Measuring Instruments
- 61–1 Pressure Measuring Instruments

Classification of Material and Equipment (Cont'd.)

61–2 Weight and Volume Measuring Instruments
61–3 Time Measuring Instruments
61–4 Velocity Measuring Instruments
61–5 Dimensional Measuring Instruments
61–6 Chemical Composition Measuring Instruments
61–9 Miscellaneous Mechanical Measuring Instruments

62 Relays
62–0 Current Relays
62–1 Differential Relays
62–2 Distance Relays
62–3 General Purpose and Specific Relays
62–4 Pilot Wire and Auxiliary Carrier Relays
62–5 Directional Overcurrent, Power, and Products Relays
62–6 Timing Relays
62–7 Voltage Relays
62–9 Miscellaneous Relays

63 Electrical Measuring Instruments (except Electricity Meters)
63–0 Ammeters
63–1 Voltmeters
63–2 Wattmeters
63–3 Varmeters
63–4 Frequency Meters
63–5 Power Factor, Reactive Factor, and Phase Angle Meters
63–9 Miscellaneous Electrical Measuring Instruments

64 Electricity Meters
64–0 Watthour Meters
64–1 Demand

ELECTRICAL EQUIPMENT

65 Motors, Generators, Rectifiers, and Controls
65–0 Motors
61–1 Generators
65–2 Motor-generator Sets, Rotary Converters, etc.
65–3 Carbon Brushes
65–4 Controls
65–5 Rectifiers

66 Transformers, Regulators, and Reactors
66–0 Power Transformers
66–1 Distribution Transformers
66–2 Street Lighting Transformers
66–3 Instrument Transformers
66–4 Distribution Voltage Regulators
66–5 Reactors
66–6 Capacitors (Static Condensers)
66–7 Tap Changer Mechanisms
66–9 Miscellaneous Transformers and Regulators

67†

68 Circuit Breakers, Switches, and Jumpers
68–0 Oil Circuit Breakers
68–1 Air Circuit Breakers
68–2 Disconnecting Switches
68–3 Safety Switches
68–4 Control Switches
68–5 Household Switches
68–7 Jumpers, Plugs, and Jumper Plug Receptacles
68–9 Miscellaneous Switches

69‡

70 Fuses
70–0 125 Volt Fuses
70–1 250 Volt Fuses
70–2 600 Volt Fuses
70–3 4800 Volt Fuses
70–4 24,000 Volt and Higher Fuses
70–5 Fuse Parts
70–6 Fuse Carriers
70–9 Miscellaneous Fuses

71 Electrical Wire and Cable
71–0 Bare Wire and Cable
71–1 Magnet and Resistance Wire
71–2 Weather-Resistant (Weatherproof Wire)
71–3 Insulated Wire and Cable
71–9 Miscellaneous Electrical Conductors

72 Electrical Connectors and Terminals
72–1 Connectors, Sleeves, and Terminals
72–9 Miscellaneous Electrical Connectors and Terminals

73 Cable Supplies and Underground Conduit
73–0 Underground Conduit and Fittings
73–1 Junction and Service Cable Terminal Boxes
73–2 Cable Protectors
73–3 Cable Splicing Material
73–4 Cable Supports

Classification of Material and Equipment (Cont'd.)

- 73–9 Miscellaneous Cable Supplies
- 74 Wiring Supplies
  - 74–0 Building Conduit and Fittings
  - 74–1 Steel Boxes, Cabinets, and Panels
  - 74–2 Receptacles, Plugs, and Sockets
  - 74–3 Lighting Fixtures and Accessories
  - 74–5 Cutout Bases (Fuse Blocks)
  - 74–6 Special Switchboard Equipment and Supplies
  - 74–9 Miscellaneous Wiring Supplies
- 75†
- 76 Electric Insulation and Insulators
  - 76–0 Insulation
  - 76–1 Insulators
  - 76–2 Insulator Hardware
- 77 Lightning Arresters
  - 77–0 (Arranged by Voltage)
- 78 Potheads
  - 78–0 Disconnecting Potheads
  - 78–1 Non-disconnecting Potheads
- 79 Street Lighting Equipment
  - 79–0 (Not used. Formerly Overhead Street Lighting Equipment)
  - 79–1 (Not used. Formerly Underground Street Lighting Equipment)
  - 79–2 Globes, Reflectors, and Refractors
  - 79–3 Luminaires
  - 79–4 Posts
  - 79–5 Supports
  - 79–9 Miscellaneous Street Lighting Material
- 80 Lamps
  - 80–0 Miniature Lamps (16 Volt and under)
  - 80–1 28 to 32 Volt Lamps
  - 80–2 120 Volt Lamps
  - 80–3 Street Lighting Lamps
  - 80–9 Miscellaneous Lamps
- 81†
- 82 Communication and Signaling Equipment and Supplies
  - 82–0 Telephone Equipment and Supplies
  - 82–1 Radio Equipment and Supplies
  - 82–2 Signs, Markers, Identification Tags, etc.
  - 82–3 Bells, Buzzers, Horns, Whistles, Annunciators, Semaphores, etc.
  - 82–9 Miscellaneous Communication and Signaling Equipment and Supplies
- 83 Batteries and Battery Equipment and Supplies
  - 83–0 Storage Batteries
  - 83–1 Dry Batteries
  - 83–2 Battery Chargers, Equipment, and Supplies
- 84†

Miscellaneous Materials

- 85†
- 86 Special Railroad Equipment, Material, and Supplies
  - 86–0 Locomotives
  - 86–1 Railroad Cars
  - 86–2 Track Material
- 87 Motor Vehicles and Equipment
  - 87–0 Passenger Automobiles
  - 87–1 Trucks, Trailers, and Diggers
  - 87–2 Tractors
  - 87–3 Valves and Caps
  - 87–9 Miscellaneous Motor Vehicle Equipment
- 88 Fuel (Except Oil)
  - 88–0 Coal
  - 88–1 Coke
  - 88–9 Miscellaneous Fuel
- 89 Lubricants, Oils, Greases, and Petroleum Products
  - 89–0 Fuel Oil
  - 89–2 Lubricating Oil
  - 89–3 Gasoline
  - 89–4 Insulating Oils and Compounds
  - 89–5 Greases and Lubricating Compounds
  - 89–6 Paraffin and Waxes
  - 89–7 Tar, Asphalt, etc.
  - 89–9 Miscellaneous Lubricants, Oils, Greases, and Petroleum Products
- 90†
- 91†
- 92 Chemicals, Drugs and Compounds
  - 92–0 Chemicals
  - 92–2 Cleaners and Polishes
  - 92–3 Disinfectants and Exterminators
  - 92–9 Miscellaneous Compounds

Classification of Material and Equipment (Cont'd.)

93 Textiles
- 93–0 Fabricated Textiles
- 93–1 Unfabricated Textiles

94 Medical Equipment and Supplies
- 94–0 Medical Equipment
- 94–1 Gauze and Bandages
- 94–2 Medicinal Compounds and Formulas
- 94–9 Miscellaneous Medical Supplies

95 Janitors' Equipment and Supplies
- 95–0 (Alphabetical Arrangement)

96 Office Equipment and Stationery Supplies
- 96–0 Furniture, Lockers, and Shelving
- 96–1 Office Machines
- 96–2 Paper
- 96–3 Printed Forms
- 96–4 Books, Magazines, etc.
- 96–5 Other Stationery Supplies

97 Restaurant Equipment and Supplies
- 97–0 Restaurant Equipment
- 97–1 Food
- 97–2 Sundries

98, 99 Items Not Otherwise Classified
- 98–0 Explosives and Firearms
- 98–1 Safety Equipment
- 98–2 Fire Fighting Equipment
- 98–3 Household Furniture and Furnishings
- 98–4 Nursery Supplies
- 98–5 Special Laboratory Equipment
- 98–6 Special Construction Equipment and Materials
- 98–7 Plating
- 98–9 Miscellaneous
- 99–0 Rubber Goods
- 99–1 Leather Goods
- 99–2 Bags, Barrels, Boxes, etc.
- 99–7 Removed Material, Not Processed
- 99–8 Salvaged Material Held for Sale
- 99–9 Material Returnable to Vendor (Reels, Drums, Lagging, etc.)

Managerial Information

BUDGETS FOR MATERIALS. As company operations and organization become more and more complex, the managerial problems of planning, coordinating, and controlling activities become more difficult. Many business administrators have found **budgeting** and **budgetary controls** to be useful tools in meeting these problems. Matz–Curry–Frank (Cost Accounting) describe budgeting

> . . . a method for coordinating the combined intelligence of an entire organization into a plan of action based upon past performance and governed by a rational judgment of factors that will influence the course of the business in the future. . . . It is an exacting and rigorous analysis of the past and a careful calculation of probable and desired future operations. The objective is to substitute deliberate, well-conceived, astute business judgment for accidental success in enterprise management.

Basis for Materials Budgets. The **sales forecast** is usually the starting point in budget preparation, although in some firms availability of raw materials or productive facilities may be the factors which determine the level of activity to be used as the bases for planning future operations. In cases where the quantity of raw materials available is the factor limiting the volume of activity, the materials budget is directly derived from the forecast of the quantity of materials that will be acquired by the firm. In other cases the demand for the product may far outstrip the ability of the firm to satisfy that demand, and the output is limited by physical facilities capable of producing the desired product. In this situation the materials budget will be geared to operation at capacity.

In most situations, however, a forecast of demand for the various products manufactured is the basis for the preparation of related plans. The quantity to

be produced will be the forecasted sales quantities, modified as necessary to achieve the desired changes in finished goods inventories. On the basis of this **production forecast,** expected materials requirements can be determined.

According to Heckert and Willson (Business Budgeting and Control) the preparation of the several related budgets for materials, purchases, and inventories involves a determination of the following:

1. The quantities of raw materials to be used.
2. The time when such materials will be required
3. The cost of materials to be used.
4. The quantities and value of materials to be carried in the inventory.
5. The quantities and cost of materials to be purchased.
6. The timing of purchases.
7. The quantity and value of work in process to be carried in the inventory.
8. The quantity and value of finished goods to be carried in the inventory.
9. The methods to be employed in controlling material costs and inventory quantities and values.

Relation to Other Budgets. The materials budget is prepared by executives of the manufacturing department and is related to the **production budget** (discussed in the section on Cost Control, Budgets, and Reports) and the **purchase budget** (described in the section on Purchasing in the Accountants' Handbook, Wixon, ed.). The production budget determines the quantities of finished product to be manufactured; from this the materials budget is developed, showing the estimated quantities of each type of raw material needed for the planned production. The purchase budget is developed from the materials budget and shows the estimated quantities and prices of each type of raw material to be purchased and the timing of these purchases. The purchase budget may be influenced very much by the level of inventories desired by top management. Inventory level is translated into specific details in the **materials inventory budget,** which accounts for the differences in the quantities used in the materials and purchase budget.

Lenhart and Defliese (Montgomery's Auditing) point out that:

> It is important to the successful operation of any business that the capital tied up in inventories be kept at a minimum consistent with operating requirements. An interruption of production or the loss of sales because of failure to receive materials or supplies at the right time can be extremely expensive. An inventory should be a live asset; the turnover of each item should be known and related to the requirements for its use in terms of minimum and maximum quantities determined with reference to the demands for it and the time requirements for reordering and delivery.

The principal **materials budget purposes** are stated by Welsch (Budgeting: Profit-Planning and Control) as follows:

1. To provide quantity data for the purchasing department so that raw material purchases can be properly planned and budgeted.
2. To provide quantity data so that the raw material costs of production can be budgeted.
3. To provide data for establishing inventory quantity standards for effective control of raw material inventory levels.
4. To provide data for determination of cash requirements (cash budget) for raw material purchases.
5. To provide data for raw material control.

Methods of Estimating Quantities. In a number of industries the quantity of each kind of raw material needed per unit of finished product is readily deter-

mined. In these cases the materials budget may be prepared by applying these unit requirements to the number of units scheduled for production in the production budget. Where a standard cost system is in operation, the **standard consumption rates** should be used as the basis for the materials budget.

When the nature of the manufacturing process makes it difficult to determine precisely the amount of raw material needed per unit of finished product, the following methods are suggested by Welsch (Budgeting: Profit-Planning and Control):

1. Ratio of the physical volume of production to the quantity of each kind of raw material. This ratio for the past months or year can be calculated from historical records and adjusted for new or changed conditions.
2. Ratio of raw material used to some measure of production, such as direct labor hours or direct machine hours.
3. Ratio of material cost to direct labor cost
4. Ratio of material cost to some measure of productive output, such as direct labor or machine hours.

It is advisable to check the reasonableness of the estimates produced by any method by comparing them with historical results.

Indirect materials and **factory supplies** are sometimes included in the materials budget along with the direct materials, but it appears that it is more usual to include these indirect items in the **manufacturing overhead budget** (see section on Manufacturing Overhead and Normal Capacity).

Economical Buying Quantity. The choice of the quantity of a material to order at a given time is determined by balancing the cost of acquisition against the cost of owning the materials. Several formulas have been developed for use in determining the most economical quantity in which purchases may be made. The accompanying formula is given by Matz–Curry–Frank (Cost Accounting):

$$Q = \sqrt{\frac{2CS}{UI + A}}$$

where Q = number of units for most economical order.
C = cost of placing an order.
S = number of units consumed in one year
U = unit price of materials item.
I = assumed annual interest rate.
A = annual carrying cost per unit.

Assume: 1,000 units of material No. 115005 are used per year, for which

Unit cost = \$5.00.
Cost to process an order = \$8.00
Annual interest rate = 5%.
Annual carrying cost per unit = 30¢.

(The last item assumes 12% annual carrying cost. \$5 ÷ 2 = average investment per unit. \$2.50 × 12% = 30¢ annual carrying cost per unit.)

Most economical order quantity:

$$\sqrt{\frac{2 \times \$8 \times 1.000}{\$5 \times 5\% + 30¢}} = \sqrt{\frac{16.000}{0.55}} = \frac{126.5}{0.74} = 171 \text{ units}$$

Matz–Curry–Frank use the accompanying table to demonstrate that in this example "the order cost and the carrying cost are approximately equal when the

order quantity approaches 171 units, and that other order quantities are not as economical. . . ."

Annual Usage	Orders per Year	Units per Order	Dollars per Order	Order Cost	Carrying Cost	Total Cost
$5,000	1	1,000	$5,000	$ 8	$300	$308
	2	500	2,500	16	150	166
	3	333	1,665	24	100	124
	4	250	1,250	32	75	107
	5	200	1,000	40	60	100
	6	167	835	48 ⟷	50	98
	7	143	715	56	43	99
	8	125	625	64	37.50	101.50
	10	100	500	80	30	110

The foregoing formula takes into consideration some of the more important factors to be considered when determining the most economical purchase quantities. There are other questions, however, which under some conditions may be of equal or greater importance.

Since the formula is substantially based on past experience, the results obtained by its use should be modified as necessary to reflect changing conditions. For example, there may be evidence indicating a change in demand for the products being manufactured by a firm. The result is that some of the materials which have been purchased on the basis of past experience would not be needed and under conditions of a changing market would become obsolete while in the firm's storeroom. At best it would be necessary to dispose of the surplus materials, but there would be the possibility of being unable to recover the costs incurred as a result of purchasing, handling, storing, and finally disposing of these materials.

The formula will also have limited usefulness when materials are subject to **physical deterioration.** In this case poor **storage and handling facilities** would also be factors influencing purchase-quantity decisions. Moreover, departures from calculated purchase quantities may be made because of management's desire to assume a speculative position with respect to inventories.

For those types of materials which are readily obtainable, it may be practical for budgetary purposes to ignore minimum quantities and to budget materials acquisitions on an equal basis with material requirements as derived from the production budget. For low-value materials that are combined or used in definite proportions, it may be possible to budget by including only a dollar amount, derived by comparing costs incurred for these items in the past with units produced and thereby obtaining a dollar cost per unit for these materials. This rate, adjusted for changes in prices expected, can be related to planned production to obtain the dollar cost to be budgeted. These, of course, would be determined by months or shorter periods, if appropriate under the circumstances.

MANAGERIAL CONTROL REPORTS. The budget as adopted is a reflection of the planned course the business is expected to follow. To conserve the time of management, **management by exception** should be employed to the extent practicable. Where business activity is proceeding according to the adopted plan, managerial attention is not required. It is in the areas where deviations from the planned course of operations are being experienced that there is need for managerial attention. Managerial control reports may serve as effective

managerial tools if designed to highlight departures from plan, if they indicate the probable reasons for the departures, and if they suggest remedial action. Lewis (NAA Bulletin, vol. 33) states:

. . . Any report shows a static situation or one developing significant changes. If it indicates change, it should also direct attention to the significant reasons for the change and offer recommendations for any necessary action. If this program is followed, management will not need to refer to numerous supplementary reports or request special studies and analyses in order to decide upon proper action to achieve desired results.

If **standard costs** are being employed, the difference between the actual and the standard unit cost may be automatically produced for reporting to management. It may be that an unnecessarily high price was paid for materials, or it may be a situation in which a price increase occurred which was not anticipated when the budget was prepared. These instances may require managerial action such as modification of the selling price of the company's product, adjusting the working capital requirements if the cost price is to remain at the higher level, or perhaps deciding that some other types of materials may be substituted at a lower cost (see section on Analysis and Control of Standard Cost Variances).

Materials Usages. With regard to usage of materials, Heckert and Willson (Business Budgeting and Control) state:

The very basis of material quantity control is to know in advance how much material should be used on the job, to secure frequently information as to how actual performance compares with standard during the progress of the work, and to take corrective action where necessary. The supervisor responsible for the use of materials, as well as his superior, should be aware of these facts. At the lowest supervisory level, details of each operation and process should be in the hands of those who can control usage. At higher levels, of course, only over-all results need be known.

A change in the amount of materials used in each unit of finished product will necessitate a revision of the purchase budget with its related effect on working capital requirements. Where production schedules are revised downward on the basis of changes in demand for products or change in the policy with regard to the quantity to be carried in inventories of finished goods, material requirements will be changed, and purchase budgets and cash requirements will be correspondingly affected. Revisions in usage factors may require revision of minimum quantities and standard quantities to be ordered. Changes in procurement time and conditions may also make it desirable to change minimum quantities.

Inventory Control. Heiser (Budgeting Principles and Practice) observes that: "Inventories merit the closest attention at all times. A constant review of stock must be maintained and deviations from planned accumulation promptly reported. Both failure to conform to the budget and the need for budget changes should be observed as soon as possible."

Periodically it is advisable to review the relationship between quantity of each type of material of significance in the inventory with its utilization. With respect to inventory control, Howard and Upton (Introduction to Business Finance) state that:

Efficient management of inventories demands that both over- and under-investment in these assets be avoided. Too much capital tied up in inventories results in a lowered rate of return and the possibility of substantial loss from decline in market value; too small an inventory is likely to reduce the volume of business and proper servicing of customers.

Inventory turnover is computed by dividing the quantity on hand into the quantity consumed during a period. It may also be expressed as the average number of days' supply of material on hand. If, for example, 18,000 units were requisitioned during a six-month period and the inventory on hand at the end of that six month period was 6,000 units, the inventory turnover for the six-month period would be three. The ending inventory would be large enough to take care of the requirements for materials of that type for approximately 60 days.

Substitution of Materials. Van Sickle (Cost Accounting) states that the engineering or production control department has the responsibility of providing for:

1. The proper quality of materials for each manufactured product
2. The proper quantity specifications for each production order.
3. The proper testing of materials received to ensure conformance with the specifications as ordered.
4. The proper flow of materials from the storeroom into the production departments.

Where alternative **material grades** are available for use in manufacturing a given product, presumably the engineering department would choose the grade which results in the least total manufacturing cost. In some cases a manufacturer may have different grades of the same general type of materials in stock for various uses. It is possible that materials other than the grade selected by the engineering department may be substituted in cases where specified materials are not available. These substitutions may have an unfavorable effect on cost of end product and should be watched carefully.

Each storeskeeper in charge of a storeroom may be required to submit a **report of substituted materials** to his supervisor when substitutions have been made. The follow-up usually consists of a review of the related **stock ledger card** to determine the cause of the shortage. The inability to furnish material as needed may have been caused by such circumstances as failure to place a purchase order in accordance with procurement instructions, delay on the part of the supplier, or unexpected demands for that type of material. If the material deficiency was caused by failure to place a purchase order as indicated by stated instructions, steps can be taken to prevent a recurrence. If the supplier failed to ship as promptly as could normally be expected on the basis of past experience, the question should be raised whether or not this represents a permanent change in procurement time which needs to be considered when determining the minimum quantity for that type of material. If there was an unexpected and unusually heavy usage of this type of material, there may be no need to change minimum stock level or standard order quantity. If the unusual utilization represents the beginning of a higher-quantity utilization of materials of this type, however, it may be necessary to change procurement instructions with respect to minimum quantities and standard order quantities for materials of the type under consideration.

Material Shortages. These usually increase cost by disrupting production processes. Some assembly processes are such that work cannot continue if a particular part is not available. A shutdown, in all probability, will have an adverse effect upon net income. In some cases it may be possible to continue production by omitting from the assembly the out-of-stock parts which will have to be installed when they become available. Installation of parts in other than planned sequence ordinarily is accomplished at increased cost. **Special cost reports** may

be prepared to reflect costs of idleness or additional costs incurred because of out-of-sequence installation caused by parts shortages.

The storeskeeper of each storeroom should be required to file daily reports listing items requisitioned for use in the plant but not in stock. It may be desirable to combine this report with the one reporting the issuance of substitute materials.

Obsolete and Surplus Stock. Inventory control not only is concerned with having materials in quantities as needed; it also encompasses the periodic review of materials in stock to detect those materials not required for planned production or for other purposes. Unneeded or obsolete materials continue to occupy storage space until removed from the storage area. The continued ownership of surplus materials and obsolete materials with some residual value increases certain storage costs such as insurance and property taxes. Materials having no planned or prospective use represent a frozen investment of enterprise funds which has an adverse affect on rate of return on invested capital.

Information regarding slow-moving materials may come from several sources. Because of his intimate association with materials stored in his storeroom, a storeskeeper may be required, on a specified schedule, to prepare a list of those materials which apparently are not needed, as indicated by lack of requisitions. Where he keeps no perpetual inventory records or records of issues, such a report would necessarily be based on his judgment. For this reason it is generally more appropriate to have the stores ledger clerk prepare such a list from inactive stores ledger cards. The disadvantage of this assignment of responsibility is that some considerable time may pass between the time a material is no longer needed and the time when this fact becomes evident on the basis of the inactive stores ledger card. A third, and perhaps better, system is to require that the production planning department review the detailed list of materials on hand and prepare a report which lists materials no longer needed either for planned or probable future production.

On the basis of this report an accounting entry should be made to transfer the cost of **surplus materials** from the Materials Control account to a Surplus Materials account. When surplus materials are sold, their cost should be removed from the Surplus Materials account, with any gain or loss on disposition credited or charged to profit and loss. If the surplus materials resulted from purchasing additional units of a particular type in order to ensure production necessary to supply products as promised, costs of disposition including loss, if any, on disposal would seem to be costs of producing those products.

The cost of **obsolete materials** reduced by estimated net realizable value may be charged to a loss account as a cost expiration without relevance to revenue. If the obsolete materials were the result of excessive purchases knowingly made in order to assure adequate supply necessary to fulfill a specific order, the difference between cost and realizable value may be regarded as a cost of the related job. If the type of manufacturing operation is such that inevitably there will be some obsolete materials, then the difference between the incurred cost of the obsolete materials and the net realizable value may be regarded as a cost of production. This cost can be spread over all production of that type by including a provision for such obsolescence in the estimated overhead when determining the **manufacturing overhead rate.**

Inventory Over and Short Report. After physically counting units of materials on hand, these results are compared with the quantities which should be on

hand as indicated by perpetual inventory records. This comparison may be made on a report form similar to that illustrated in Fig. 2.

In those cases where a custodian is solely responsible for materials in his storeroom, it is desirable that a separate report be prepared for each storeroom, thereby associating discrepancies with specific individuals. Where discrepancies are significant, custodians may be required to furnish explanations.

INVENTORY OVER AND SHORT REPORT

Storeroom: ______________________ Date: ______________

Number of Cards Checked: ________ Number Incorrect: ____________ Percent Incorrect: __________

Material Code	Item	Physical Count	Stores Record Count	Actual OVER UNDER Physical	Unit Cost	Adjustment	
						Increase	Decrease

Physical Count Made by: ____________ Unit Costs by: ________________

Physical Count Checked by: __________ Extensions and Footings by: ________

Fig. 2. Report on inventory overages and shortages.

The materials control acount and related subsidiary ledgers should be corrected as necessary to reflect actual quantities on hand as disclosed by the physical inventories.

Information for Financial Statements

COST DETERMINATION FOR FINANCIAL STATEMENTS. Financial statements are among the most important products of accounting processes. It is desirable, therefore, that accounting procedures be designed to provide information needed for these statements.

With regard to accounting for materials, this problem can be subdivided into two parts:

1. **Determination of the cost of materials acquired.** This part of the problem has many subproblems. Should gross invoice price, net invoice price, or price actually paid be regarded as the basic cost of acquired materials? How should "freight-in" be added to the cost of materials? Should acquisition costs (purchasing and handling costs) be added to the basic cost? What accounting treatment should be accorded storage costs? These aspects of the problem of accounting for materials are discussed in detail in the Accountants' Handbook (Wixon, ed.).

2. **Determination of the part of materials cost to be transferred to work in process.** The cost of materials not transferred will be presented in the current asset section of the balance sheet. Cost of materials destroyed or damaged by forces not inherent in the manufacturing process should be deducted as losses in the income statement of the period in which the loss was suffered.

There are several methods for determining the portion of the cost to be transferred to work in process. Among the more commonly used methods are the identifiable cost; first-in, first-out; last-in, first-out; moving average; and standard cost methods.

Identifiable Cost. Under this method, purchases made for particular jobs are kept physically separate in the storeroom, and **stores cards** are made out for the individual purchases. When materials are issued for jobs, **requisitions** are priced at the exact cost, as recorded on the appropriate stores cards. This system may be somewhat awkward, but is employed effectively when nonstandardized units have to be purchased to meet a customer's specifications. Some concerns operating on a job order basis use this method to price issues of materials not regularly carried in stock, and use some other method to cost materials regularly used in production.

First-in, First-out. The first-in, first-out method (FIFO) assumes that items first received are the first to be issued and that requisitions are priced at the cost at which these items were placed in stock. For example, if 100 units of material *X* are purchased at $1.00 per unit, and later 200 units at $0.90 per unit, the first 100 units to be used are priced at $1.00 per unit and next 200 units at $0.90 per unit. In the use of this method, care must be exercised in pricing requisitions filled from two or more lots (Fig. 3).

Date	Receipts		Issues			Inventory		
	Qty	Unit Cost	Qty.	Unit Cost	Amt.	Qty	Unit Cost	Amt
Jan. 5	100	$1 00	..	. .	...	100	$1 00	$100
7	. .	....	30	$1 00	$30	70	1 00	70
10	200	.90	..	...	...	70 200	1 00 .90	250
15	...	....	70 40	1.00 .90	106	160	.90	144
18	100	1 10	..	...	...	160 100	.90 1.10	254
20	...	....	50	.90	45	110 100	.90 1.10	209

Fig. 3. First-in, first-out method.

Last-in, First-out. This method of pricing requisitions assumes that the last items purchased are the first to be used, the balance on hand being priced at the cost of the earliest purchases. By this method, current income (sales) tends to be charged at current (replacement) cost. For example, if 200 units of material *X* are purchased at 50 cents per unit, and at a later time 400 units cost 60 cents per

unit, the first 400 units to be used are priced at 60 cents per unit, and next 200 units at 50 cents per unit. As in the first-in, first-out method, care must be exercised in pricing requisitions calling for two or more lots and in recording balances on stores cards when two or more differently priced lots are on hand.

The arithmetic involved in keeping stores records under this method is similar to that necessary under the first-in, first-out procedure. The point to remember is that requisitions are priced at the cost of the most recent purchases (Fig. 4).

Date	Receipts		Issues			Inventory		
	Qty.	Unit Cost	Qty	Unit Cost	Amt.	Qty	Unit Cost	Amt.
Jan 5	100	$1.00	..	...	...	100	$1.00	$100
7	...	...	30	$1.00	$30	70	1.00	70
10	200	90	..	.	...	70 200	1.00 90	250
15	...	...	110	90	99	70 90	1.00 .90	151
18	100	1.10	..	...	...	70 90 100	1.00 .90 1.10	261
20	...	....	50	1.10	55	70 90 50	1.00 .90 1.10	206

Fig. 4. Last-in, first-out method.

The perpetual last-in, first-out (LIFO) inventory procedure, illustrated here, is one of several **unit-cost** LIFO methods, so-called because the valuations are based on specific unit costs. Another form of computation known as the **dollar basis** or **dollar-value** LIFO method applies price indices to the total dollar value of homogeneous groupings of inventories. Although used primarily by department stores, it is also used by other types of business, including some manufacturing companies.

Moving Average. This method, called the **weighted average** or **running average** method by some accountants, is used by those concerns which desire to spread total costs evenly over all goods on hand. To calculate the moving average unit cost, the procedure is:

1. Add total quantity received to total quantity on hand
2. Add cost of materials received to cost of those on hand
3. Divide total values by total quantities.

Average unit cost is used in pricing requisitions and balances on hand until new purchases are received, when it is necessary to calculate a new average unit cost. The arithmetic involved in this method is illustrated in Fig. 5. The value of the ending inventory is found as follows:

1. Units on hand	210
2. Last average unit cost	$ .99288
3. Value of inventory (210 × $ 99288)	$208.50

Date		Receipts		Issues			Inventory		
		Qty.	Unit Cost	Qty.	Unit Cost	Amt	Qty.	Unit Cost	Amt.
Jan.	5	100	$1.00	...	....	....	100	$1.00	$100.00
	7	...	....	30	$1.00	$30.00	70	1.00	70.00
	10	200	.90	...	....	....	270	.92593	250 00
	15	...	....	110	.92593	101.85	160	.92593	148.15
	18	100	1.10				260	.99288	258 15
	20	...	....	50	.99288	49.64	210	.99288	208.51

Fig. 5. Moving-average method.

It should be noted that there is a difference of 1¢ in the balances arrived at by multiplication ($208.50) and by subtraction ($208.51) in spite of the fact that the unit cost was carried to five decimals. Where it is the practice to carry the unit cost computation to only a specified point, such as the nearest full cent or the nearest tenth of a cent, there will be greater discrepancies between the control account balance, arrived at by subtraction, and the sum of the balances of the stores ledger cards if the latter are obtained by multiplication. If, in the above example, the practice was being followed of computing the unit cost to the nearest cent, 99¢ would be the unit cost used for the last transaction. The cost of the 50 units issued on January 20th would then be $49.50 rather than the $49.64 shown. The previous balance of $258.15 less $49.50 would be $208.65. The 210 units on hand multiplied by 99¢, however, would give a balance of only $207.90, a difference of 75¢.

To avoid these annoying and unnecessary differences between the control account and its subsidiaries, the total cost of the units issued should be subtracted from the old balances on the stores ledger cards to obtain the new balances rather than obtaining the latter by multiplication. Since the same figures are being used in both the control and in the subsidiary accounts for cost of materials issued and both are being subtracted from the same old balances, the new balances should be the same.

The difference of 75¢ in the balance obtained by the two different methods in the above example would not accumulate to a large figure. Each time a new average was computed, this difference automatically would be included in the amount to be divided to obtain the new average.

Another average sometimes used is computed by dividing the total cost of the beginning inventory plus the purchases during the period by the total number of units included in these two groups. This method is called the **periodic average** or the **weighted average** method. It is particularly useful in a process cost system because the cost of the material used is charged to production at the end of the month. Some companies use the average computed at the end of one month to cost the requisitions of the following month. It should be noted that the phrase "weighted average method" is used by different persons to refer to two different systems, the moving average and the periodic average.

The Accountants' Handbook (Wixon, ed.) gives a comprehensive discussion of the advantages and disadvantages of these as well as other inventory methods.

Standard Cost. Under this method requisitions of materials are priced at some predetermined or standard cost. The accounting procedure for materials under a standard cost system depends upon which of the following methods is used:

1. Materials are kept at actual costs on stores cards and priced into process at standard.
2. Materials are kept at standard cost on stores cards and priced into process at standard

If stores ledger accounts are to be kept on an actual cost basis, and requisitions are priced at standard, the stores ledger clerk keeps his records in the usual manner, but the cost clerk uses the standard prices to charge to production, with the difference between actual and standard cost being handled through a Material Variance account (see Section on Operation of Standard Costs).

When standard costs are used from the point of receipt on through production, the accounting procedure for the receipt and issue of materials is greatly simplified. Under this method, only quantities of receipts and issues need be recorded on stores cards. When materials and supplies are received, the Stores Control account is charged at standard cost, the difference between actual and standard being charged or credited to a Material Price Variance account. At the same time the quantity received is entered on the proper stores card in the Received and Balance sections, the **standard unit price** being noted at the top of the ledger card. When requisitions are made, entries for quantities only are placed in the Issued sections and deducted in the Balance sections of the appropriate stores card. The standard costs of materials to be used on each job may be recorded on a cost sheet in advance. It is necessary for the cost clerk to determine from time to time the variance in quantity used, the latter being handled through a Material Use Variance account.

Procedures and Forms

STORES LEDGER CARD. Procedures and forms should be so formulated that accounting functions related to physical control, managerial decision making, and preparation of financial statements will be facilitated. Control of materials is made more effective by the existence of information which discloses the types and quantities of goods that ought to be in each storage area or storeroom. This may be accomplished by the use of a general ledger control account supported by perpetual inventory records. The perpetual inventory records may be in the form of stores ledger cards, one form of which is shown in Fig. 6 by Devine (Cost Accounting Analysis and Control).

Basic Information. As a minimum, the heading of each stores ledger card should contain information which clearly identifies material being accounted for on that particular card. It is desirable that the name assigned to a material be concise and at the same time descriptive. Brevity of title saves time for those who need to write the names of materials. **Descriptive titles** minimize the likelihood of errors and confusion in recording information relevant to particular materials.

The heading of the stores ledger card may include additional information which will contribute to the effective accounting for control of materials. Where there are several storerooms and the materials are such that their location is not immediately apparent, it may be desirable to include in the heading of the stores card

STORES LEDGER CARD

Item ______________________ Maximum ______________________

Code ______________________ Minimum ______________________

Location ______________________ Order Quantity ______________________

Delivery Time ______________________

ORDERED			RECEIVED					RESERVED		ISSUED					BALANCE	
Date	Order No.	Quan.	Date	Order No.	Quan.	Unit Price	Amt.	Job No.	Quan.	Date	Order No.	Quan.	Unit Price	Amt.	Quan.	Amt.

Fig. 6. Stores ledger card.

the designation of the storeroom and the **location** of the particular materials within that storeroom.

The individuals who keep stores ledger cards are in an excellent position to observe the quantity of each material on hand. If furnished with instructions to initiate a **purchase** requisition for a specified quantity when the level of a given type of stock reaches a predetermined level, control of investment in stock becomes a matter of routine. As additional information, some manufacturers have found it desirable to include on each stores ledger card the expected **material requirements** by months as based upon planned production. A comparison of monthly material requirements with information related to specified quantities to be purchased and time required to secure needed materials may disclose the inadequacy of existing minimum quantities as stated on the stores ledger card.

In the lower portion of the stores ledger card there should be, as a minimum, information about quantities of materials received, issued, and on hand. Some manufacturers have found it worth while to include information regarding quantities on order and also quantities on hand that have been reserved for use on a particular job or production order. Where the type of material under consideration is quite costly and where quantities required vary considerably from month to month, it may be desirable to control quantities of materials more carefully through keeping information about quantities on order and those reserved, in addition to the usual information with respect to quantities received, issued, and on hand.

Ordered Materials. If an ordered section (Fig. 6) is used, it should include the date, purchase order number, and quantity ordered. Relating the date an order was placed to the time required, as indicated in the heading of the stores ledger card, makes it possible to predict approximately when an ordered quantity is likely to be received. By comparing purchase order numbers in the ordered section with those listed in the received section, it is possible to determine which orders have been received and which are still unfilled.

If the individual who keeps a particular stores ledger card is authorized to follow up on orders placed but not received within a reasonable time, such follow-up activity may be facilitated by including the name of the **vendor** as a part of the information in the ordered section of the stores ledger card. The information to be recorded in the ordered section of a particular stores ledger card is generally obtained from a copy of the **purchase order** which is supplied to the keeper of the stores ledger cards by the purchasing department. The information on quantity received is obtained from receiving reports supplied by the receiving department.

Received Materials. The received section of the stores ledger card (Fig. 6) contains information obtained from **receiving reports** and **invoices**. As materials are received, they are counted and inspected, and a receiving report is prepared to record their receipt. A copy of this receiving report together with a copy of the related invoice is furnished the stores ledger clerk for use in recording relevant data on the stores ledger card. The cost ("Amt." in Fig. 6) may include invoice price less trade and cash discounts, plus transportation charges, costs of unloading, and handling costs. In some cases an additional amount is added to cover **storage costs** up to the time of use. Since the stores ledger cards usually constitute a subsidiary ledger, costs entered in total in the Materials Control account in the general ledger must be entered in detail in the subsidiary ledger, i.e., the stores ledger cards. Because of difficulties involved in allocating freight-in to several types of materials received in mixed shipments and in handling and

storage costs where several types of materials are involved, it may be easier to include these costs as a part of manufacturing overhead and to relate these costs to products as a part of burden.

As a matter of convenience, **materials returned to stores** may be recorded as receipts on the stores ledger card. Actually these receipts are cancellations of issues and should be recorded as subtractive items in the issues section of the stores ledger card. The cost of materials returned to stores during a period would be totaled and the following entry made:

Materials	$........	
Work in Process		$........

Materials Reserved. The **reserved** section (Fig. 6) is used to disclose quantities of a particular material reserved for production orders as listed. A **material reservation tag** may be attached to the materials bin to indicate the quantity of materials of that type reserved for the production order indicated on the tag. A comparison of the balance on hand, as shown on the stores ledger card, with the quantity reserved discloses the amount of that particular type of material that is otherwise immediately available for use in the factory. It may be desirable to instruct the stores ledger clerk to subtract reserved quantities from the actual balance on hand in determining whether or not the minimum quantity has been reached, and when this is the case, to submit a purchase requisition to the purchasing department.

Materials Issued. The issued section (Fig. 6) contains information regarding quantities of the particular material issued. The typical entry shows the date of issue, the stores requisition number, the production order number, quantity issued, and cost of materials issued on the basis of that requisition.

Materials Returned to Vendors. The cost of materials returned to vendors during an accounting period is removed from the Materials Control account by the following entry:

Accounts payable or due from vendor	$........	
Materials		$........

As materials are removed from storerooms and returned to vendors, it is necessary to remove the related costs from the stores ledger cards affected. This may be accomplished by entering either the cost of returned materials as a negative amount in the received section or as a positive amount in the issued section of the stores ledger cards. The first treatment appears to be preferable, since materials returned to vendors are not issues of materials but are more in the nature of **purchase cancellations** or cancellations of receipts. It may be expedient, however, to record these as issues, thereby eliminating negative figures in the received section. Where this expediency is employed, care must be exercised to eliminate the cost of materials returned to vendors from the total cost of materials issued when determining inventory turnover or calculating consumption factors for the materials under consideration.

Balance of Materials. The balance section of each stores ledger card usually includes the quantity on hand and the total cost of the material for which that card is maintained and may include the unit cost. The cost of materials on hand at the end of an accounting period, as determined by adding the separate final cost amounts in the balance section of each of the stores ledger cards, should equal the balance of the Materials Control account in the general ledger. The quantities of

the various materials, as shown in the balance sections of the stores ledger cards, should also be in agreement with physical quantities actually on hand in the storage areas.

STORES REQUISITION. The materials requisition or stores requisition is a written order authorizing the storeskeeper to issue specific materials and supplies to the person presenting the requisition. In many plants **materials requisitions** are prepared by the production-planning personnel as a part of their preparation of production schedules. These are delivered to the storeskeeper in accordance with production schedules, directing delivery of materials to specified locations in the plant. In other plants the preparation of materials requisitions is left to foremen of departments, while in others this responsibility is given to employees who are in need of materials. In the latter situation it is not uncommon to find the requirement that the foreman's signature must be obtained before submitting the requisition to the storeskeeper.

The types of information usually included in a stores requisition is illustrated in Fig. 7 by Schlatter and Schlatter (Cost Accounting). The number of copies to be prepared will depend upon whether the issuer of the requisition is required to maintain a file of requisitions issued. If the user maintains a file, then it is

MATERIAL REQUISITION

Requisition No.________
Production Order No.________ Store No.________

Specification	Description	Quantity	Unit Price	Total
	Totals			

I have received the above material.
Date: ________
Signed: ________

Issue the above material.
Signed: ________

Fig. 7. Materials or stores requisition.

desirable to prepare three copies, with two of these being submitted to the storeskeeper, who retains one as receipt for materials issued and sends one to the stores ledger clerk who enters unit cost and total cost data. The clerk also enters in the issued section of the stores ledger card the quantity and cost of materials issued and determines the new balance on hand for that type of material.

MATERIALS REQUISITION RECORD. Where the number of requisitions is comparatively small, it is common practice to record them in a materials

requisition record (Fig. 8) which serves as a book of original entry. The several columns are totaled and posted to accounts in the general ledger as indicated in the columnar headings.

MATERIALS REQUISITION RECORD

Period Covered: ______________

Date	Requisition Number	Production Order Number	Debit				Credit			
			Work in Process	Factory Overhead	Other		Material Code	Quantity	Unit Cost	Total
					Acct. No.	Amount				

Fig. 8. Record of materials requisitions.

In those situations where there is a large volume of requisitions submitted to stores, it is not practical to employ a materials requisition record. Under these conditions requisitions are sorted according to object of use and are totaled. The adding machine tapes attached to the bundles of requisitions serve as the basis for the following entry:

Materials in Process or Work in Process	\$........	
Factory Overhead or Overhead Department X	\$........	
Other expense accounts	\$........	
Materials		\$........

It is necessary to prepare separate requisitions where more than one storeroom is to furnish needed materials because a copy must be retained by the storeskeeper as evidence of his release of accountability. It is also necessary to prepare separate requisitions for materials to be used on different **production orders** because ultimately these requisitions will be sorted by job orders or production orders and the cost data listed on the requisitions entered on the appropriate cost sheets or analysis sheets.

BILL OF MATERIALS. Some companies prepare a master list of materials required for a job, as illustrated in Fig. 9. This is made up by the planning or engineering department. A copy is sent to the storeskeeper to be used by him as a blanket authorization to issue materials as listed on this bill of materials. This is particularly useful where the quantities of various materials to be used are standardized and where these can be delivered as a single issue to the using

department. In some cases the bill of materials is made up in such a way that storeskeepers are instructed to deliver materials according to a specified schedule.

The use of a bill of materials makes it unnecessary to write individual requisitions for each type of material in quantities as needed at various stages in the production schedule. When items are issued at various stages rather than in total at the start of production, some way must be provided for keeping the stores ledger cards up to date. This may be done by keeping a record of quantities of various types issued on the authority of the bill of materials and periodically using this as the basis for making entries on the stores ledger cards.

At the end of an accounting period, the total cost of materials issued must be determined either by totaling costs as entered on the bills of materials or by adding the cost of materials issued as listed on the issued section of the stores ledger cards.

RETURNED MATERIALS REPORT. In the manufacture or assembly of some types of products, experience indicates that inevitably some materials or parts are spoiled. Under these conditions it may be desirable to issue a somewhat larger quantity of materials or parts than probably will be needed to complete the work. When this practice is permitted, there may be a tendency to allow unused materials to accumulate in various parts of the plant.

Inventory pockets of this type are not under accounting control. Requisition records and stores issues cards reflect these materials as having been issued and charged to work-in-process. Through normal accounting processes these costs have been included in cost of goods finished and perhaps subsequently have been transferred to cost of sales. Since there are no accounting records which indicate the existence of these unused materials, the only deterrent to the unauthorized removal from the plant by a dishonest employee is to be found in the likelihood of the removal attracting the attention of fellow workers, supervisors, or guards.

In some cases materials unused on jobs and left in manufacturing areas are exposed to the danger of **physical damage.** If allowed to accumulate in substantial quantities, there may be the danger of **deterioration** or perhaps **obsolescence** of these materials.

Even though the costs of these materials have been charged to jobs, in reality the enterprise continues to have an investment in them. Unless they are physically returned to stores or at least accounting recognition given to their existence outside of the stores area, the stocks of these types of materials may be replenished prior to the time this action would be justified as based on stated minimum quantities. As a consequence, enterprise funds are required to carry a larger inventory in total than is warranted on the basis of production needs, procurement period, and cost of purchasing and receiving ordered materials.

Adjustment of Accounts. From a cost standpoint, it is equally important that unused materials be given appropriate accounting recognition. The costs of the unused materials, having been included among those costs charged to specified production orders, are included in the total cost of materials transferred from the Materials Control account to the Work-in-Process account in the general ledger. Since these materials were not needed on the job or production order indicated on the stores requisition, it is appropriate that their related costs be removed from the Work-in-Process account and returned to the Materials Control account. These costs should also be removed or deleted on the **cost sheet or production order sheet** on which they were first entered and should be reentered on the appropriate stores ledger cards.

Date* 4-2- FE-900

DPA Front Axle | Sheet 1 of 1 | BM- 1 Special | First Chassis | Model 629 Aramco Bus

Item No.	Part Number	SC	DESCRIPTION		Quan.				
1	FE-900	P	Timken Front Axle		1				
2									
3	K150-B-29	FC	Hub		2				
4	32309	P	Studs, RH		10				
5	32310-	P	Studs, LH		10				
6									
7	W223-B-73	P	Front Springs						
8	K174-B-115 & R	C	U-Bolt Pad		2				
9	K241-A-17	X	U-Bolt, Spring to Axle		1 ea.				
10	3/4" NF	P	Esco High Nut - U-Bolt Retaining		8				
11	K264-A-9	P	Rubber Bumper W/C-69 Pad		2				
12	5295	P	Threaded Bushing Two per Spring		4				
13	5299	C	Link, Shackle		4				
14	6262	P	Pin, Drive Bracket		2				
15	1/2" NC x 3 1/2"	P	Capscrew, and Esco Nut		8 ea.				
16	5296	P	Pin, Shackle		4				
17	1/2" NC x 2 1/4"	P	Capscrew and Esco Nut		8 ea.				
18									
19	306	P	Vickers Spring		1 ea.				
20	AX-44518	P	Vickers Shield	Draglink	1 ea.				
21	44782	P	Vickers Cover	Shield	1				
22	K213-A-165	P	Shield		1				
23									
24	3/4 NF x 1 3/4"	P	Capscrew		4				
25	3/4 NF	P	Esna Nuts		4				
26									
27	1610-B	P	Lube Fitting		14				
28	43716-R	P	Lube Fitting Body 45°		2				
29	A-15077 & 78	P	Houde BBLB Shock Absorbers	Per R268-B-367	1 ea.				
30	K162-B-23	P	Houde Shock Links, 8 1/2" C to C		2				
31									
32	8668	C	Caster Plate, 1/2", 1", 2", 3" (as required)						
33									
38									

Item	Date	Was	Item	Date	Was	Item	Date	Was
	4-2-	Rewritten						

Sheet 1 of 1 | B M - 1 Special

Kenworth Motor Truck Co.

Fig. 9. Bill of materials.

To serve as the basis for these accounting entries, a **returned materials report** is usually prepared similar to Fig. 10 adapted from Vance (Theory and Technique of Cost Accounting). From the standpoint of internal control, the person authorizing the return of materials to the storeroom should initiate the returned materials report. In some cases, however, the storeskeeper receiving the returned materials is assigned the related task of preparing the returned materials report. Under these circumstances, if he fails to prepare the report, he is left in possession of these materials, and there will be no accounting record indicating that he is accountable for them.

DUNSMORE COMPANY
Returned Materials Report

Materials Returned From: ______________________ Dept. — Date ______________

Credit (job or process) ______________________

Stock No.	Units Returned	Remarks	For office use: Unit Cost	For office use: Amount

Made by:	Approved:	Received: Storeskeeper	Entered:

Fig. 10. Returned stores slip.

Unit Cost Data Used. Persons originating returned materials reports ordinarily will have information concerning types and quantities of materials being returned to stores, but they will not have unit cost information necessary to complete these reports. The partially completed, returned materials reports are usually sent to stores ledger clerks who are able to furnish unit cost figures as derived from copies of **requisitions** or **stores ledger cards.**

Materials returned to stores are in effect cancellations of previous materials issues. Wherever feasible they should be returned to stores, carrying the same unit costs as were used when originally issued. Where direct identification is not practicable, alternative procedures may be used. If it is assumed that unused materials of a given type originated from the last requisition for that particular type of materials, the unit cost appearing on that requisition may be used as the

Date	Req. No.	Job or dept.	Description	Materials control Cr.	Materials in process Dr.	Factory overhead control Dr.	Selling cost control Dr.	Administrative cost control Dr.	Plant and equipment Dr.	Sundry		
										Amount Dr.	L.F.	Account

Fig. 11. Returned materials record.

unit cost of items being returned to stores. If it is assumed that unused materials of a particular type were an accumulation resulting from several requisitions, an average unit cost derived from these requisitions could appropriately be used when re-entering these materials on the related stores ledger card.

Journal Entries. The returned materials reports will serve as the basis for removing from the costs of the related production order the cost of materials returned to stores. The total cost of materials returned to stores during the accounting period will be journalized as follows:

Materials	$........	
Materials in Process or Work in Process...............		$........
Overhead (indirect materials)..........................		$........
Other accounts as appropriate.........................		$........

Where the number of returned materials reports is not large, a returned materials record similar to Fig. 11 by Blocker and Weltmer (Cost Accounting) may be used as the book of original entry in which the details of each returned materials report are recorded. If the number of such reports is large, however, adding machine tapes supported by copies of these reports may be used to support the summary entry.

There may be some situations in which it is not practical to return the unused materials physically to the storeroom. For example, the next scheduled job may be one which will require materials of the types unused on the previous job. In order to relate costs to jobs on the basis of materials actually used, and in order to have stores ledger clerks and storeskeepers informed of material on hand, it is necessary to prepare a returned materials report (Fig. 10) and to make the foregoing entries as though the materials were physically returned to the storeroom. The difference, of course, will be that a notation on the stores ledger card should be made to show that these materials are in the plant rather than in their usual storage place.

SUPPLIES USED AS RAW MATERIALS. As a general rule, there is a definite distinction between materials purchased for production and those purchased for supplies. These two groups are often segregated. In such cases control accounts are established in the general ledger for "Raw Materials" or "Direct Stores," or by some similar title, to record direct materials. Indirect materials or supplies are recorded in a separate "Supplies Control" account. Withdrawal of direct materials is distinguished from withdrawal of indirect materials by the use of different forms or of different colored requisitions. If materials ordinarily used as direct materials are withdrawn for use as indirect materials, an indirect material requisition is used. On the other hand, if materials ordinarily classified as indirect materials are withdrawn for use on production orders, a direct material requisition is used. Direct material requisition numbers are run as a separate series and are readily distinguished from the serial numbers used to identify indirect material requisitions.

BIN TAGS. Some firms follow the practice of attaching tags similar to that illustrated by Blocker and Weltmer (Cost Accounting) in Fig. 12, to bins, shelves, or racks, and require each storeskeeper to maintain perpetual inventory records (usually quantities only) for the various materials stored in his area. In some cases a separate tag is made up for each incoming lot of material, and the quantity, order number, and date of receipt of goods are entered in spaces provided. When the material represented by the bin tag is issued in accordance with stores

or materials requisitions, the date of the issue and the quantity released is entered in the issued column and a new balance determined. As new lots of material are received in the storeroom, the related bin tags are placed behind those in current use. No entries are made on the bin cards related to recently received lots until the bin tag related to the oldest lot shows that lot to have been exhausted. Periodically the storeskeeper may send a report of balances of various materials on hand to the stores ledger clerk who compares this information with quantity balances recorded on the related stores ledger cards.

STOCK CARD

Location________________ **Maximum**________________

Material________________ **Minimum**________________

Date	Quantity received	Quantity issued	Balance	Condition

Fig. 12. Stock tag placed in bin or on shelf.

Perpetual inventory records maintained both on bin cards and on stores ledger cards obviously represent duplication of effort. Nevertheless, some firms have found it advisable to use bin tags where very current information regarding available stock is needed and is not immediately available from stores ledger cards because of delay in recording information related to receipts and issues.

Before deciding to maintain perpetual inventory records on bin cards, some difficulties likely to be encountered should be considered. For example, if a storeskeeper has many types of materials in his storeroom and serves many employees in the plant, he may be under pressure to issue materials promptly, and his record keeping may suffer as a result. He may issue materials, making a mental note that he must record the quantity issued on the bin tag. He may forget to record the issue, or he may record the issue hastily and determine a new balance, making some mechanical errors in his calculations.

It should also be recognized that requiring storeskeepers to keep records places a clerical function upon storeroom personnel who may not have the aptitude or interest necessary for the satisfactory performance of this type of work. As a result, records kept by them may be illegible, or the recording functions may be completely neglected.

According to Vance (Theory and Technique of Cost Accounting) a more important use for bin tags is to be found in connection with the taking of **physical inventories.** When all or a substantial part of the inventory must be counted for a particular closing date, it may be necessary for this inventory process to be spread over several days because of the impossibility of completing the required count in any one day. As a materials category is counted, the total quantity on hand is entered on the bin tag. From that time until the end of the period, a perpetual inventory record is maintained to disclose receipts and issues of that type of material. At the end of the period the bin tags are collected, and the quantities are determined by physical count which is adjusted for receipts and issues which occurred between the time of the count and the end of the period. These adjusted figures are then used as the physical count made at the end of the period.

PUNCHED-CARD SYSTEM OF INVENTORY CONTROL. Many firms having a large volume of transactions affecting inventory have found it advantageous to utilize punched-card or similar equipment in keeping records of material requirements, ordered materials, materials received, materials issued, and balance on hand. (For a general discussion of machine accounting, see section on Basic Cost Records.) Heckert and Willson (Controllership, The Work of the Accounting Executive) state:

> The vast amount of detail, the use of inventory transactions for purposes other than inventory control, and the necessity for a continuous review of inventory make the use of punched-card equipment quite valuable in many concerns. From the same data, a number of records or reports can be run. The perpetual records showing receipts, disbursements, and balance can be prepared from the same cards from which summaries of usages are run. Automatic computation of average inventories and turnover rates is possible from the inventory transaction cards.

While a variety of punched-card accounting systems are available, International Business Machines Corporation (IBM Accounting—Inventory Control and Material Accounting) illustrates the electric machines and accounting forms used and shows the flow of accounting data under the electric punched-card accounting method in Fig. 13. Three basic **punched-card forms** are designed and used for recording transactions affecting materials and supplies:

1. Materials balance card (Fig. 14).
2. Materials received card.
3. Materials requisition card (Fig. 15).

In addition to these basic cards, many organizations find it desirable to have the following cards:

1. On-order cards.
2. Inventory adjustment cards

Materials Balance Card. At the time when punched-card accounting for inventories is installed, an accurate determination is made of the quantity of each type of material on hand. One balance card (Fig. 14) is prepared for each type of material. Transactions affecting each type of material are sorted by material type and used as the bases for preparing up-to-date balance cards. This can be done as frequently as circumstances dictate. The illustrated balance card discloses the **quantity available.** This is obtained by adding receipts and subtracting issues from the opening balance and by adding to the ending on-hand balance the quantity on order and then subtracting the minimum quantity. If the available figure is a negative amount, this indicates that even after receipt of those

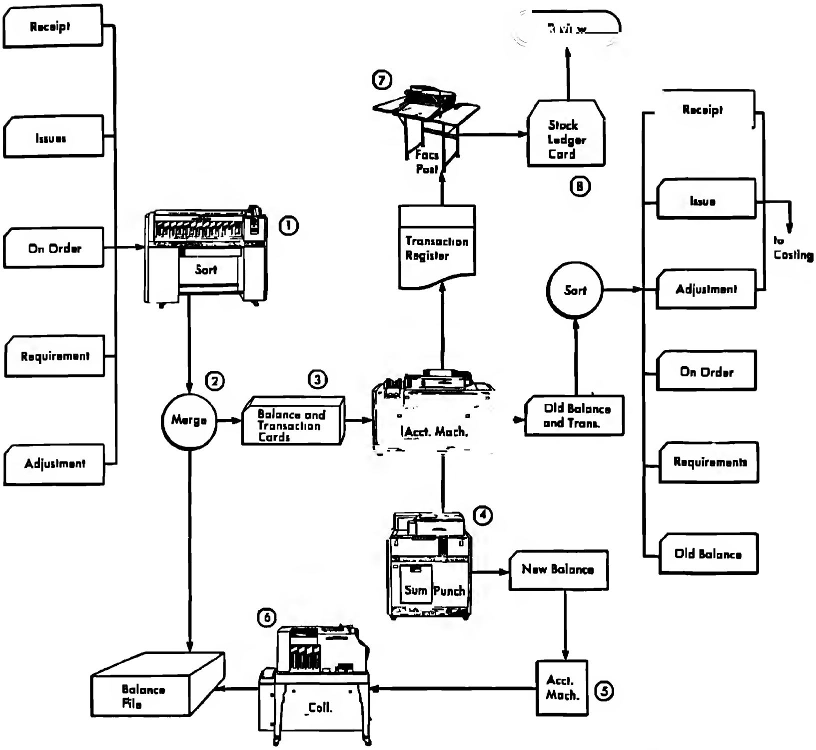


Fig. 13. Flow chart of punched-card inventory system.

units on order, the resulting quantity will be below the minimum quantity, and there is therefore need to place an order for more materials of that type. The balance cards having a negative figure in the available field can be machine-selected. A list of items to be purchased may be prepared from these selected cards.

By dating materials balance cards when prepared and by not changing these dates except when an issue or receipt occurs, it is possible to list stock on hand by types of materials and show the last active date for each—a useful list for detecting obsolescence.

Materials Received Card. The received card has fields for material class, stock number, purchase or production order number, quantity received, and amount of charge. Within the limits of the card, other types of information can also be punched. These cards are punched daily from production orders, receiving slips, and vendors' invoices. A file of **open-purchase commitments** can be maintained by reproducing the on-order cards and removing the open-purchase cards from the file as goods are received. These cards can then be processed as receipt cards, and the on-order file can be kept up to date.

Materials Requisition or Issue Card. The requisition or issue card (Fig. 15) usually has fields for date, material number, production order number, quantity

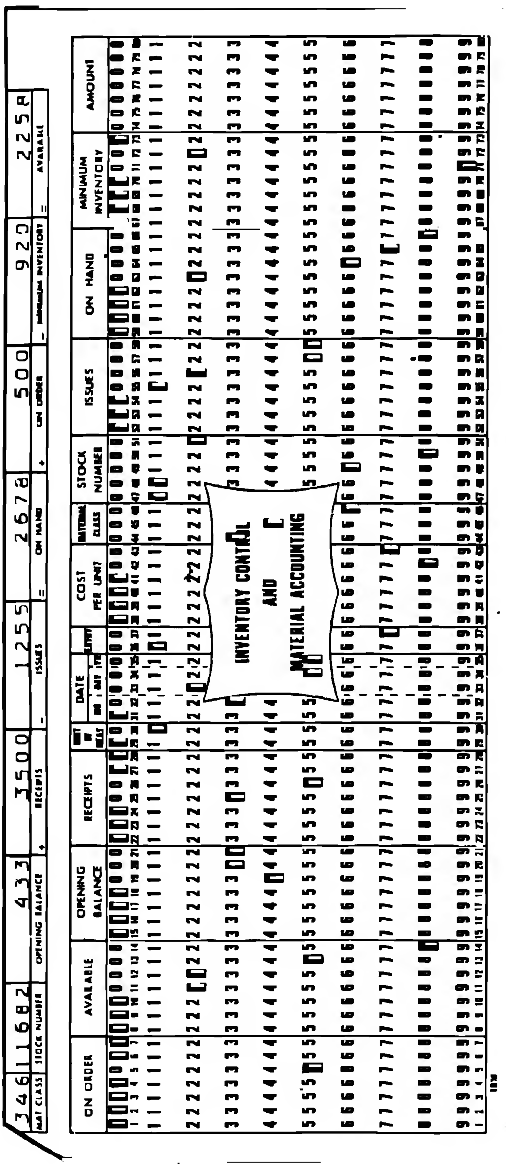


Fig. 14. Materials balance card.

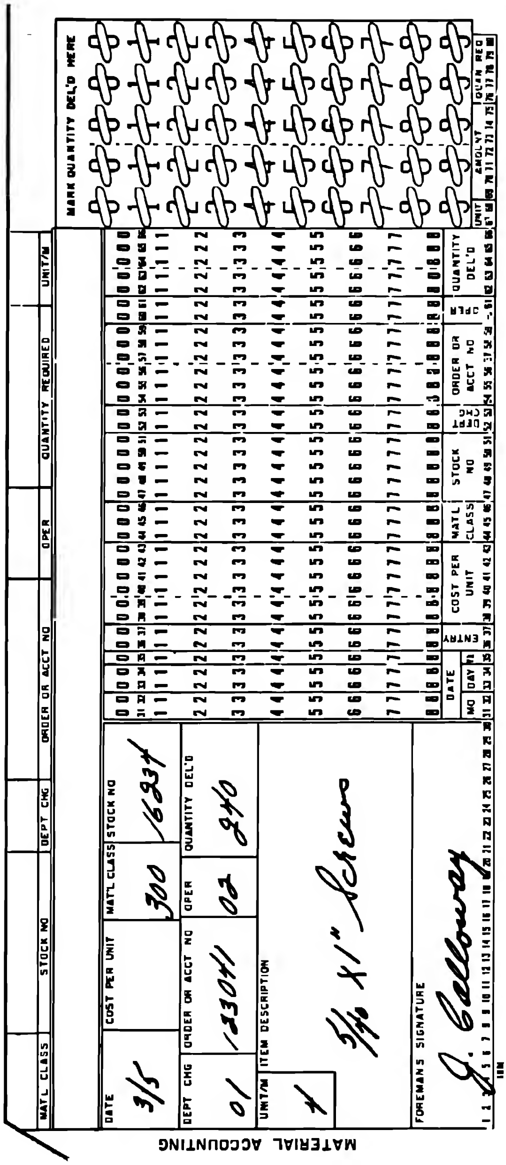


Fig. 15. Materials requisition or issue card.

issued, cost per unit, and amount. The cards are punched daily, and the totals are checked for accuracy. After they are punched and checked, they are placed in a collator with the **price cards.** The latter are punched for each kind of material, new cards being made as prices change. The collator automatically files a price card ahead of each group of requisition cards for a particular material number. The price and requisition cards are then run through an automatic **multiplying punch.** This machine automatically picks up the price for a particular material number, multiplies it by the quantities on each requisition for that material, and punches the computation into the requisition card. As materials numbers change, it clears out the old materials price and picks up a new one.

The next step is to place the materials receipt cards, requisition cards, and balance cards in a collator. The collator rejects any balance cards which are not affected by the day's transactions. These cards are returned to the balance file. The collated cards are then tabulated and a **current material record** of active items is prepared.

Some firms prepunch requisition cards on the basis of expected material requirements on the various job orders. This is possible where a standard quantity of specified materials is used on a job of a given type. A reservoir of these prepunched cards is maintained, and cards are withdrawn for machine processing as related materials are issued to the plant. Even where the quantities required are not standardized, it may be convenient to have a tub or reservoir of requisition cards which have been prepunched except for those data that are variable, such as date, quantity issued, and production order on which the requisition materials are to be used. Space can be left for these data on the requisition card and can be filled in at the time materials are issued. An alternative is to utilize what is referred to as **mark-sense recording.** At the time materials are issued, the quantity delivered and the account number to which these will be charged are marked in spaces provided. Later these cards can be passed through mark-sense punch equipment which will automatically punch the mark-sense information recorded on the card.

Materials requisition cards can be sorted by types of materials and total utilization by types reported. Coupled with ending balances in inventory, this provides information regarding **inventory turnover,** or when viewed in terms of days, the number of days' materials requirements on hand.

On-Order Card. When the quantity on hand of a given type of material drops below a predetermined level, it is desirable to have in operation a system which automatically discloses this situation and facilitates the procedures to be followed in securing the needed replenishment of that material. Where receipts and issues are related daily to the balance cards, provision can be made to have the machine-accounting equipment prepare a list of the types of materials needing replenishment. This list may be used by the purchasing department as authorization to place orders as indicated.

Equipment is available which automatically produces the on-order as a by-product of the preparation of the **purchase order.** This may be done directly or from a punched tape which is prepared as the purchase order is typed.

The on-order cards are processed with the day's receipts and issues in the production of new balance cards, and the on-order information will thereby appear on the new balance cards. At the time that ordered materials are received, the related on-order cards must be removed from the on-order deck so that these will not continue to appear as materials on order on the balance cards after the related materials have been received.

Inventory Adjustment Card. It is quite typical to encounter circumstances which do not fall into either the receipt or issues categories. Discrepancies between the physical quantities actually on hand and the quantities that should be on hand, as disclosed by perpetual inventory records, require that the perpetual inventories be adjusted accordingly. Materials returned to stores are not materials received but are cancellations of quantities issued. Materials returned to vendors are not materials issued but represent cancellations of materials received. Materials may be damaged, may deteriorate or become obsolete, and may thus require appropriate accounting recognition. Adjustment cards may be used to distinguish these from the usual receipts and issues of types of transactions affecting materials.

Transaction Register. The transaction register is a report which can be prepared on the accounting machine. Cards for every type of transaction involved (issue cards, receipts, on-order, requirements, adjustments) which can affect the inventory or its requirements in any way are sorted by **stock number** and **material class.** These cards are then processed in the collator to select and merge with the **current balance cards** for the corresponding active items. According to International Business Machines Corporation (IBM Accounting—Inventory Control and Material Accounting):

> This report can then be prepared in various ways, depending on the ultimate purpose of the analysis. The cards may be listed in detail, or they may be summarized by stock number.
>
> The report may highlight activity by material class such as steel, phosphorus, or cotton. Or it may be broken down by form: steel rods, explosives, yard goods. The make-up of the report will be determined by the sequence of the documents to which it is to be posted, or by the significance of the analysis for which it is being prepared.
>
> The transaction register should be printed with a carbon impression on the reverse side of the sheet. This will make it possible to use the facsimile posting machine in posting the historical-ledger cards

During the running of the transaction report, new balance cards are summary-punched with revised current information. These new cards are then filed back into the balance-card file by using the high-speed collator.

Stock Ledger. An operator using the facsimile posting machine can prepare stock ledger cards, using the transaction register as the source material. Postings to the stock ledger cards are accomplished at speeds ranging from 500 to 1,000 lines per hour. The facsimile posting machine prints an entire line at a time. Information regarding material number, production order, purchase order, etc., can be included without slowing the speed of operation because entire lines from the transaction register are transferred to the stock ledger cards as units.

Under this type of operation it is not necessary to balance stock ledger cards. In the event that an error has been made on a given stock ledger card, this will be corrected automatically when the next posting-machine medium is prepared from the punched-card balance file. The stock ledger card provides a historical record of activity related to the material being recorded thereon.

For analytical purposes the receipt cards, issue cards, on-order cards, and balance cards can be sorted and summarized in many ways. It is also possible to use some of them in connection with other accounting processes:

1. Receipt cards can be sorted and reports prepared on materials acquired from each vendor, showing materials acquired by broad or general classes of materials, by time period within the month, by accounts charged, etc. Some

punched-card systems utilize receipt cards in connection with accounting for accounts payable.

2. Requisition cards can be sorted and reported by general materials classifications, by production order, by department requisitioning material, by date requisitioned, etc. They may also be tabulated with related labor and overhead distributions, thus reporting costs of work in process by production orders.

3. On-order cards can be summarized by vendor, by classes of materials on order, by expected dates of receipt (if this information has been included in the card), etc.

The limits restricting analyses are only those that are imposed by the manner in which the basic data are recorded and by the machine time available for processing the punched cards into the desired order and for printing the reports.

The following **advantages** are to be found in the use of punched-card accounting for inventory control (IBM Accounting—Inventory Control and Material Accounting):

1. Stock status reports are always available for review of all stock items. They are valuable guides to purchasing and production and serve many other needs as well.
2. An up-to-date historical record of stock is very easily obtained by posting the stock ledger daily.
3. A complete record of work in process is provided.
4. Minimum supplies can be ordered on an economical basis.
5. A steady flow of supplies to assembly and production lines is provided.
6. Lower overhead results from maintaining economical but adequate stock and by minimizing handling, storage, deterioration, and similar other costs.
7. Concise and current records make available many analytical and statistical reports as by-products of the inventory control procedure.

USE OF PUNCHED CARDS IN TAKING PHYSICAL INVENTORY. Firms employing machine accounting for materials frequently find it advantageous to use punched cards as forms on which physical inventory counts are recorded. When this system is used, much of the clerical work related to the usual process of obtaining an accurate inventory can be performed by accounting machines. If maximum utilization of punched-card equipment is to be obtained, it is desirable that individuals making the physical counts be required to record only the identification of each type of material counted and the quantity of each type on hand. It is possible to perform practically all other necessary operations by utilizing various types of punched-card equipment.

Each enterprise using punched-card equipment in connection with the taking of physical inventories is likely to have some peculiarities either in types of materials, storage conditions, or in types of information desired. These peculiarities necessarily modify the types of information to be included on the **inventory cards.** It is possible, however, to describe the basic plans in general terms.

Single Card with Detachable Stub. Inventory counts frequently are made by individuals working in pairs, one recording the physical counts determined by the other member of the team. Each team is furnished with a quantity of serially numbered inventory cards such as that illustrated in Fig. 16 or Fig. 17 (IBM Accounting—Inventory Control and Material Accounting). The recorder enters on the card the type of material or identification of material together with the quantity as counted by the other member of the team, and the card is then attached to the bin, rack, or shelf. If deemed desirable, recounts are made by **inventory checkers.** When the checking of accuracy of recorded quantities has

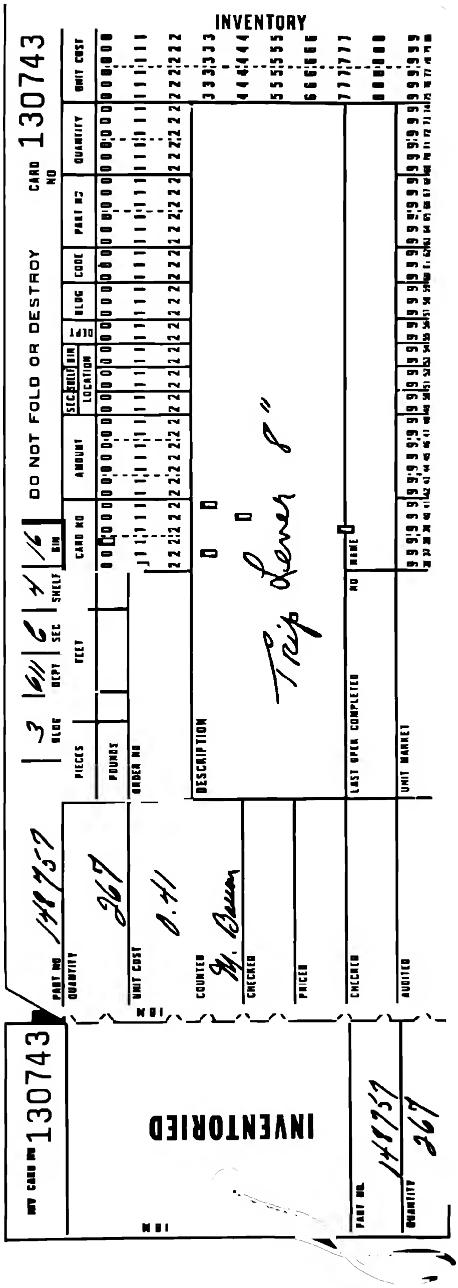


Fig. 16. Serially numbered inventory card with detachable stub.

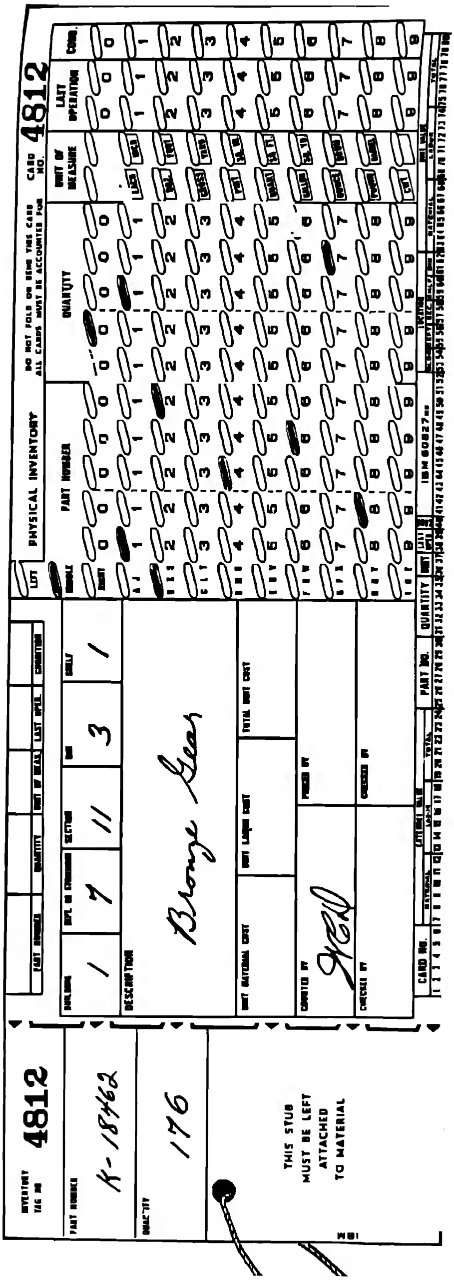


Fig. 17. Mark-sense inventory card.

been completed, the basic parts of the inventory tags are removed and processed by accounting machines. The stubs left attached to shelves or bins indicate to the inventory supervisor that items have been counted as recorded, thus making it easy to identify materials not included in the physical count.

Mechanical equipment may be employed to ensure that all the serially numbered inventory tags have been accounted for. Information regarding recorded material code numbers and quantities as entered on the cards by the recorders must be punched into the respective cards. Then it becomes possible to transfer desired and related information from the stores ledger cards to the inventory cards by means of mechanical equipment. This includes such items as unit cost and location.

From the **completed inventory cards** various listings can be prepared. For example, a list by material code number may be prepared for the whole organization as for each storeroom. Other alternatives are available, depending upon the various types of information recorded on the inventory cards.

Mark-Sense Card. Many firms have found that the use of mark-sense type card (Fig. 17) in taking inventory has many advantages. The effectiveness of the system is not dependent upon the ability of the recorder to write legibly. He simply fills in spaces on cards as appropriate, these markings are read mechanically, and the recorded information is automatically punched into the inventory card. The rest of the inventory determination is accomplished in the same manner as described in previous paragraphs.

Under some systems the inventory cards are prepunched to include material description, code number, and location as basic information. The cards are then sorted by location, thus facilitating the work of the inventory teams. The disadvantage of this method is that there may be a tendency to count only those materials for which cards are provided, with the result that some items may not be counted.

Electronic Data Inventory Application. In recent years some firms have installed electronic data processing equipment and have transferred their **inventory records** to such equipment. (See section on Basic Cost Records for a discussion of electronic data processing equipment.) As an example of such a system, the East Pittsburgh Division of Westinghouse has placed 34,000 different stock items in the Univac data automation system (Sperry Rand).

The Univac data automation system in this case consists of three groups of equipment: input, central computer, and output. The **input units** serve to convert data from various sources, such as purchase orders, requisitions, and receiving reports, to magnetic tape, the form in which it can be "read" by the computer. The Univac typing unit and the card-to-tape converter record data from various sources on magnetic tape. The **central computer units** perform the processing functions. The **output units** convert data recorded on magnetic tape to other useful forms. Results can be printed at a maximum of 600 lines per minute on a high-speed printer. Each line has a capacity of 130 digits. Univac equipment is also capable of preparing typewritten copy from magnetic tape and a tape-to-card converter prepares punched cards from magnetic tape.

In Fig. 18 (Westinghouse East Pittsburgh Division, Univac Data Automation System, Inventory Control Application) the flow chart shows basic input, consisting of the daily transaction tape which has been prepared to reflect all changes affecting inventory which occurred on a particular day, and a data-carried-forward tape. These tapes are processed and the computer produces a sorted-daily-transactions tape which contains all daily transactions plus the data carried

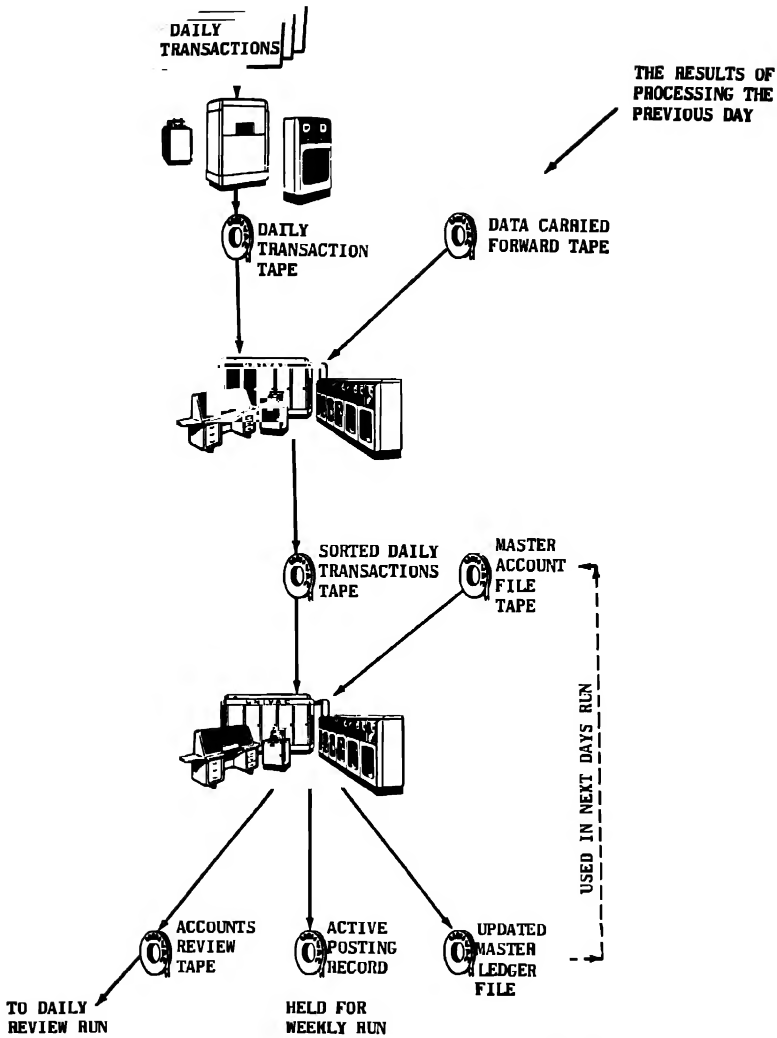


Fig. 18. Flow chart of basic computer input for inventory control.

forward from the previous day. This sorted-daily-transaction tape is then processed with the master-account-file tape producing:

1. An updated master ledger file.
2. An active posting record, listing the postings made on each active account, which will be held for the weekly run.
3. An accounts review tape, listing accounts to be reviewed in a subsequent run.

The accounts review tape (Fig. 18) is the basic input for the daily account review. The computer reviews the accounts, determining whether or not material

orders are to be placed or expedited, or outstanding orders extended. The output of this processing is an account requisition tape which contains the accounts for which requisitions are needed and the necessary information to print the requisition. If expediting or extension of outstanding orders is indicated, the tape will also contain this. The account requisition tape then serves as the input in further processing from which the data-carried-forward tape and the daily-reports tape are produced.

A weekly transaction report is produced from the accounts record tapes or active posting records (Fig. 18) for the five daily review runs and contains all active accounts and the nature of the activity for the week.

The master ledger file (Fig. 18) is processed to produce the inventory information needed for the monthly reports. A new master ledger file is also produced. During the processing each account is examined for activity during the completed month. If an account has been active, the activity date is extracted and placed on an output tape. At the same time, the portion of the master account file containing these activity accumulations is "zeroed out" thereby producing a clean master ledger file for the following month's processing.

Scrap

DEFINITIONS. Some accountants as well as nonaccountants use the terms "scrap," "spoilage," "waste," and "by-product" interchangeably. These terms describe the **residual materials** or substances that result from manufacturing activities. They are similar in that they are incidental to the achievement of the basic objective of producing satisfactory products. They appear as the inevitable consequences of operations. They are also similar in that they ordinarily have little value as compared with the major products. While admitting the similarities, many accountants feel that there are significant differences which make it desirable to distinguish these terms both in definition and usage. Thus Lang–McFarland–Schiff (Cost Accounting) distinguish the four terms as follows:

> A by-product is an article of value incidental to the manufacture of the main product or else it may be made from waste material arising from such manufacture. . . . Waste is that portion of basic raw material lost in processing, having no recovery value. Some companies have through research converted what was unsalable waste to a revenue-yielding by-product.
>
> Spoilage is the defective portion of regular production having a value only recoverable through reprocessing. Scrap is the incidental residue from certain types of manufacture recoverable without further processing The principal difference between scrap and a by-product is one of degree of value.

The terms "spoilage" and "waste" sometimes are used to indicate the loss in value rather than the material itself. Thus Schlatter and Schlatter (Cost Accounting) define **spoilage** as the "loss resulting from the accidental destruction of value of work in process." They describe **waste** as the loss which results from the disappearance of materials in the manufacturing process (such as evaporation) or the decline in value of some materials placed in process, recognizing that ". . . qualities may disappear without the disappearance of quantity of the materials itself."

ACCOUNTING FOR SCRAP. In accounting for scrap, sound theory would indicate that the value assigned to it should be its "cost." However, as Schlatter and Schlatter (Cost Accounting) state ". . . it is utterly impossible to determine that cost. The accountant is forced to resort to reasonable allocation."

The cost accounting problem faced in this situation is very similar to that encountered in accounting for **joint products** and **by-products.** To allocate, on the basis of weight the cost of a sheet of tin to the end pieces used in the manufacture of tin cans and to the irregular scrap pieces remaining after removal of those end pieces does not seem to be "reasonable." A more reasonable approach is based on the assumption that competent management reaches its decision to manufacture a product or products on an over-all consideration of costs and related revenues. The basic end product may be the production of ends for tin cans, uppers for shoes, sleeves for coats, etc. At the same time it is recognized that inevitably some pieces of the original material will remain. If these have a ready market and it is the intention of management that these be disposed of in the market, management may consider whatever is recovered by the sale of scrap as serving to reduce the cost of producing the primary product.

Treatment When Sold. If the scrap under consideration has a stable value in the scrap market, this may be used as the basis for recognizing the appearance of **scrap inventory** and thus reducing the cost of manufacturing the basic products. Following this line of thought, the cost of scrap to be entered in the scrap inventory and removed from **work in process** or **finished goods** should be determined by subtracting expected marketing costs related to the eventual disposition of scrap from its sales value. In this way the net amount recovered is the amount by which cost of producing the primary product is reduced.

The following entry would be made to record the appearance of scrap materials:

Scrap Inventory	\$.	
Work-in-Process		\$.......

In job-lot cost accounting, the Materials-in-Process account may serve as a control account supported by cost summary sheets for jobs or production orders in process. Under these circumstances, the detail of the credit in the foregoing entry must be posted to the individual cost summary sheets.

If the value of scrap produced is significant and if the quantity varies from job to job, it may be desirable to identify the scrap produced by each job and reduce the material cost of each job by the sales value of related scrap produced. Only in rare cases, however, would this procedure appear to be justified. If several **production orders** are in process at a given time, each producing similar or nearly identical types of scrap, it might be quite difficult and costly to attempt to associate the value of scrap produced with the individual production orders. Under these conditions, the value of scrap produced may be regarded as a reduction in the cost of all production orders worked on in each department in which scrap originates. Devine (Cost Accounting and Analysis) suggests that "When the work on various jobs is equally exacting and the amount of scrap varies with the amount of materials used, a blanket assignment in proportion to materials is not unreasonable."

If scrap produced bears approximately a direct relationship to machine hours or direct labor hours and manufacturing overhead is being charged to jobs on the basis of machine hours or direct labor hours, another expedient method of dealing with scrap is available. If the estimated realizable value of scrap expected to be produced in a department is subtracted from the estimated manufacturing overhead related to that department in the **burden rate determination** made at the beginning of the year, the result is that the burden rate for that department will be somewhat smaller than would otherwise be the case. By charging each job with a smaller amount of burden, the effect is that the total cost of each job is

reduced in recognition of the fact that it produced scrap that had some value. Devine (Cost Accounting and Analysis) states:

It is sometimes easier to estimate the scrap for a period and in estimating the period's manufacturing cost, make allowance for the scrap as a reduction. This procedure is easy to apply when the cost accounting system calls for the use of estimated overhead charges. Under this method the scrap credit is spread according to the formula used for assigning overhead and not according to the amount of actual scrap on each job. It should be realized that this accounting treatment is based upon expediency rather than logical justification, for there is little, if anything, in amounts received through sale of scrap which is directly or indirectly related to overhead When this method is adopted, the following entry is made to set up scrap inventory:

Scrap Inventory	$........	
Manufacturing Overhead or Burden....................		$........

A third alternative allocates no cost to the scrap resulting from manufacturing activity, and the entire proceeds realized from its sale are considered miscellaneous income. This procedure is often followed in those situations where the realizable value is uncertain because of radical fluctuations in the market for scrap. It may also be used when the realizable value is relatively small, perhaps being little more than sufficient to cover marketing costs that will be incurred in disposing of it. Under this method no accounting entry related to the appearance of scrap occurs until scrap is sold. At that time the following entry is made:

Cash, or Accounts Receivable...........................	$........	
Miscellaneous Income, Scrap...........................		$........

The foregoing entry cannot be regarded as based on sound theory. Implicit in this entry is the questionable assumption that no part of the original material cost was related to the scrap. The uncertainties of market price, the difficulties encountered when an attempt is made to estimate marketing costs related to disposition of scrap, and in some cases the desire to be conservative may be regarded by some accountants as sufficient justification for the use of this method.

Treatment When Reprocessed. The foregoing discussion assumed that the scrap was to be disposed of in the market. An alternative is that it can be reprocessed into useful raw material for subsequent production of basic products. For example, the scrap material from sheets of metals from which parts have been stamped may be melted and again formed into sheets from which more units may be stamped. If this scrap is of the type currently being purchased for processing into sheets, the most recent acquisition price may be used as the basis for the entry:

Raw Materials Inventory	$........	
Work in Process..		$........

In some cases it may be necessary to process scrap materials before returning these to raw materials. Under such conditions the amount by which the cost of goods produced or work in process will be reduced will depend upon the cost which will be incurred in the further processing of scrap for raw material use. If the costs of the necessary processing are approximately equal to the acquisition cost of raw materials in the regular markets, the cost of producing the basic product will not be reduced. In this borderline situation a special cost study may be desirable to determine whether or not there are some indirect costs related to the processing which under usual procedures would be excluded as processing costs. Management's decision in such cases ought to be made with appropriate

recognition being given to investment in facilities that are used for further processing and the effect that this activity has on the rate of return from invested capital.

MANAGERIAL CONTROL OF SCRAP. Since scrap materials per pound or per square foot usually have less value than the same units of measure found in the original raw material form, an obvious objective of managerial control is to keep scrap output within acceptable limits. Stated positively, this requires maximum effective **utilization of raw materials** being processed. It means getting the most product from a given quantity of raw materials.

Effective scrap control does not begin at the producing department. It begins in **product design.** This is the point where decisions are made with respect to the shapes that individual parts must have. It is also the place where **material specifications** originate. Since the type of materials to be used and the shapes of the forms to be cut or otherwise fashioned from these materials are crucial in the effort to control scrap, it is essential that these factors be given adequate consideration when designing the product.

Selection of **manufacturing equipment** also has an important effect upon the quantity of scrap to be expected. Equipment that is not well suited to the type of processing required is not likely to obtain the maximum quantity of product from a given quantity of raw materials.

The **selection and training of personnel** who are to process the materials also are functions which have scrap control ramifications. The type of operation to be performed may be of a nature that requires a highly skilled operator if maximum utilization of materials is to be achieved. In these circumstances the assignment of a less skilled operator may be expected to secure less product and more scrap from a given quantity of raw materials.

Acceptable Scrap Quantities. The factors of product design, materials specifications, production equipment, and labor force (separately and collectively) influence what finally emerges as a schedule of quantities of scrap to be regarded as acceptable at various levels of productive activity. In addition, scrap may be the result of administrative decisions. For example, a manufacturer may receive an order for a number of units of a particular type as described in specifications furnished by the customer. The specifications may be such that in all probability some completed units will not pass final inspection. Assuming that the number rejected cannot be accurately predicted, management must choose between two alternatives: (1) produce the required number and await inspection when the required additional units will be determined, or (2) produce a large enough quantity on the initial run so that there will be a sufficient quantity passing inspection to fill the order.

If the course of action indicated in the second of these alternatives is followed, it usually will result in producing more satisfactory units than actually necessary to furnish the number ordered by the customer. Several conditions may cause management to select this alternative. **Set-up costs** may be sufficiently large to make it cheaper to produce an excess of units than to set up a second time to produce units needed to replace those rejected. The customer may require prompt delivery of acceptable units. For this reason it may be necessary to make sure that at least the number of satisfactory units ordered will be produced on the first run. In either case, management's decision is to produce more units than will actually be required.

Perhaps the customer placing the original order can be persuaded to purchase the remaining satisfactory units at a reduced price, which still may be greater

than the value to the manufacturer as scrap material. If not, and if they cannot be otherwise disposed of as manufactured products, their value, if any, is as scrap materials.

Scrap Control Reports. Effective scrap control requires clearly defined areas of responsibility together with a system of reports which present information concerning performance within the specific areas of responsibility. Ailman (NAA Bulletin, vol. 31) states: "The cost accountant can report a bad situation in scrap loss but, if there are no clearly defined responsibilities in regard to scrap loss, his efforts will produce little in the way of results."

Effective scrap control also requires the prompt reporting of the appearance of unexpected large amounts of scrap. The sooner information concerning the appearance of abnormal amounts of scrap reaches supervisory personnel, the sooner corrective action can be taken.

SCRAP REPORT

Department________________ Date________________

Type of Scrap	Basic Product	Satisfactorily Completed	Allowable Scrap	Actual Scrap	Actual OVER UNDER Allowable	Cause and Planned Corrective Action

Fig. 19. Report on scrap.

Fig. 19 illustrates a report on scrap appearing on a date indicated and in the department stated in the heading. This report could be used by a first-level

THE NOVELTY MANUFACTURING COMPANY SCRAP REPORT—STAMPING DEPARTMENT

For the Week Ended November 23, 19__

Description		No. of Pieces		Percent Scrapped	Cost	Reason
Part No.	Name	Production	Scrap			
617C	Hinge	12,320	207	1.68	$ 8 28	
871R	Ring	8,620	73	.85	3.65	
1422	Flap	3,110	672	2.16	282.24	Defective die
1816	Support	8,520	40	.47	16.00	
1871	Spoon	11,890	90	.76	1.80	
2167	Ruler	1,245	–	–	–	
2173	Cap "R"	14,505	1,070	7.38	$107.00	Substitute material
2271	Cap "T"	8,140	72	.88	21.60	
	Total				$ 440.57	
	Cost of Scrap—Year to Date				$18,497.12	

Fig. 20. Summary scrap report.

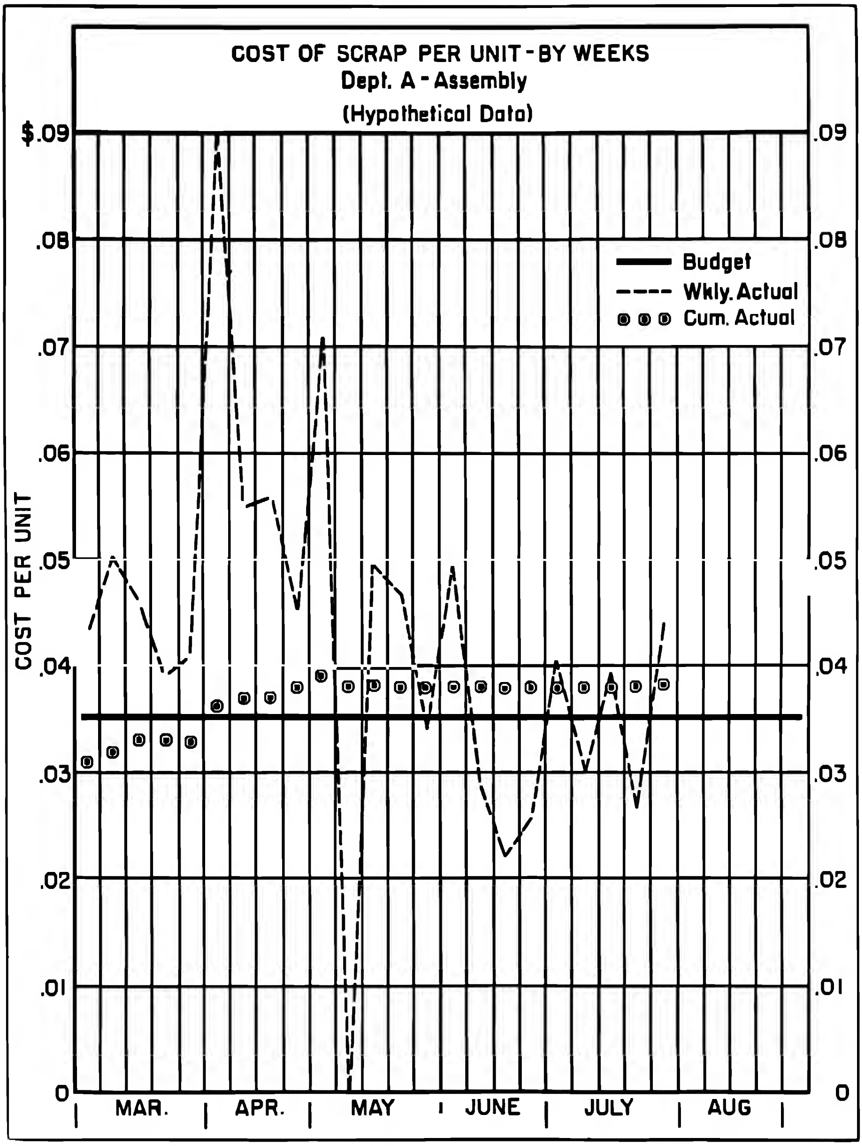


Fig. 21. Scrap analysis reflecting trend of variance from allowed cost of scrap per unit of production.

supervisor to record the appearance of scrap. It would be forwarded to his immediate supervisor, who would review performance together with planned corrective action where appropriate. Copies of reports of this type may be summarized for presentation to higher echelons in the organization of factory management. Heckert and Willson (Controllership) give an example of such a report in Fig. 20. In Fig. 21, Stockmeyer (NAA Bulletin, vol. 35) shows a scrap report expressed in terms of weekly cost per unit. Copies of reports like Fig. 19 can also be used as the basis for preparing accounting entries to recognize the appearance of scrap.

A somewhat similar chart that might be used to keep operating personnel informed of scrap produced in relation to volume of parts satisfactorily completed is shown in Fig. 22. A **control limit line** such as that on the chart in Fig. 22 calls attention to any rise of actual scrap above the acceptable level.

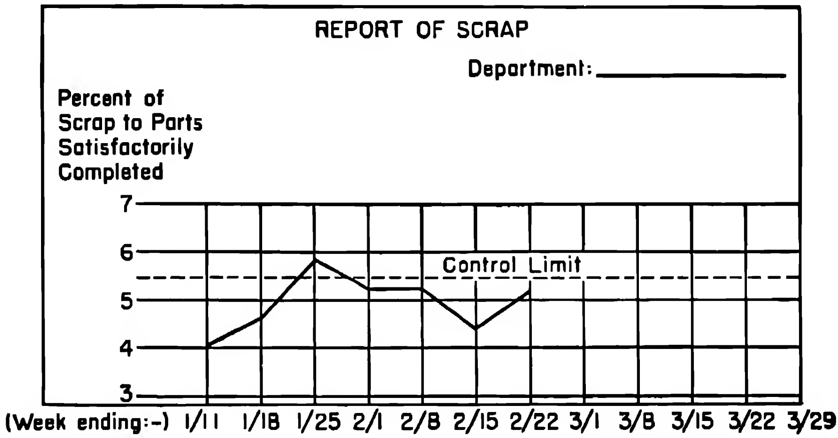


Fig. 22. Graphic scrap report.

Spoilage and Defective Work

DEFINITIONS. Spoilage results when materials are so damaged in manufacturing operations that they are taken out of process and disposed of in some manner without further processing. Spoiled materials cannot be repaired or reconditioned as is done in the case of defective work. Sometimes spoiled work must be sold as seconds (as in hosiery manufacturing), but at other times it can be salvaged only as scrap and either sold or used as raw materials in the manufacturing processes. In either case there is not only a material loss in the product but also a loss of labor and manufacturing overhead already incurred on the material.

Defective work consists of imperfect products which are brought up to standard specifications by the application of additional material, labor, or both. Defective work may be the result of any number of causes, such as poor materials, incompetent supervision, carelessness in planning, poor workmanship, inadequate equipment, and laxity of inspection. To be classed as defective work, the product must have additional labor, material, and plant services applied to bring it to the point of acceptability. These items constitute **re-operation or rework costs** incurred in correcting imperfections so that the product meets the required standards of quality.

ACCOUNTING FOR SPOILAGE. Spoiled units may appear as the inevitable result of manufacturing. Atwater (NAA Bulletin, vol. 32) states "The foundry that can produce castings without rejection due to defects is still a figment of the imagination." He stresses the importance of efforts to keep such spoilage at minimum levels because "excessive amounts of scrap cause serious inroads on a company's profit."

Where spoiled units appear to be the inevitable consequence of efforts to produce acceptable units, such spoilage is described as **normal spoilage.** It logically follows that the cost of producing satisfactory units includes the cost incurred from spoiled products.

Units may be spoiled as the result of such events as floods, earthquakes, fires, and riots. Such forces are not inherent in manufacturing processes, and related losses can be described as **abnormal.** According to Vance (Theory and Technique of Cost Accounting): "Normal spoilage may be illustrated by the occasional breaking of a precious stone in cutting it; abnormal spoilage by the breakage of glassware in an earthquake." Regarding the accounting treatment to be given abnormal spoilage, Vance states, "The costs of abnormal spoilage are charged to a loss account where they have no further effect on the costs of the good product."

The cost of spoiled units includes the original cost of raw materials as well as the cost of materials subsequently added, labor, and manufacturing overhead up to the point of accidental damage. Schlatter and Schlatter (Cost Accounting) state: "Spoilage consists not only of loss of value of material but also of loss of expenditures for labor and factory burden incurred in the work already done on the material."

Treatment Dependent on Residual Value. In some cases spoiled units have no residual value. Under these conditions even the costs to be incurred in disposing of such units can properly be regarded as a cost of producing the related satisfactory units. If these spoiled units are the result of exacting specifications of a particular job, and if the disposal costs are material in amount, the disposal costs should be regarded as a part of the cost of producing units as specified on their production order. If the spoiled units are the result of mass production of products of a given type, however, disposal costs may be regarded as an indirect cost and allocated to all products by means of including **estimated disposal costs** as a part of factory overhead at the time the overhead rate or rates are determined.

Under the first set of circumstances, where spoiled units are caused by **exacting specifications,** the payment for disposition would be recorded by the following entry:

Finished Goods or Cost of Sales........................	\$...	
Cash, Accrued Wages, etc.		\$........

If the spoiled units appear as a result of **mass production,** the following entry would be made:

Factory Overhead (or Disposal Costs to be closed to Factory Overhead)............................	\$........	
Cash, Accrued Wages, etc.		\$........

If spoiled units have some residual value as scrap or as "seconds," the problem arises regarding the amount of cost to be assigned to such units. Where the

spoiled units have value only as raw material, the prevailing acquisition price for materials of this type may be used as the basis for determining the cost to be assigned to the scrap materials. The difference between accumulated cost and the scrap value is the "loss of value" arising from the accidental damage of units in process, defined as "spoilage."

Spoiled units may have a very nominal and uncertain **realizable value.** Under these conditions it may be impractical to attempt to allocate any cost to such spoiled units. When these units are sold, the following entry can be made:

Cash or Accounts Receivable..........................	$........	
Miscellaneous Income		$........

Since no cost was assigned to these spoiled units, it appears that the miscellaneous income was realized without the incurrence of any costs for material, labor, and overhead. This treatment cannot be justified except on the basis of expediency. Paton and Littleton (Introduction to Corporate Accounting Standards) contend: "A particular class of revenue may be subordinate in amount and from the standpoint of the technical organization of operation, but it does not follow that it is cost free."

An alternative expedient treatment is to record the sale of spoiled units by the following entry:

Cash or Accounts Receivable	$........	
Factory Overhead		$........

The theory underlying the credit to Factory Overhead is that the total cost incurred in producing all units will be reduced by the amount recovered through the sale of spoiled units. The predetermined overhead rate is slightly reduced by subtracting estimated sales value of spoiled units from overhead in the overhead rate calculation.

Cost Allocation of Grades. In some cases spoiled units may be sold through regular marketing channels but at prices which are graduated according to the prominence of flaws. In the hosiery industry, for example, the spoiled products may have value as "seconds," "thirds," etc. Various methods for allocating costs to the different grades have been suggested. Among the more common methods proposed are:

1. Allocate the same amount of cost to the seconds as to the first grade units. This can be described as "treatment by neglect." The fact that spoiled units have been produced is ignored when determining the unit cost of goods completed. There is no "loss of value" classified as spoilage. In some cases this procedure will result in allocating more cost to second grade units than will be recovered through their sale. Many accountants object to this type of cost allocation as being illogical and prefer to use a by-product or joint-cost type of accounting as described in methods 2 and 3.

2. Assign to "seconds" the costs derived by deducting expected marketing costs from the sales value of such units. Under this method the "loss in value" will be the difference between the accumulated cost up to the point where the units were spoiled and the net realizable value.

3. Assign cost to "seconds" on the basis of their sales value less the percentage of gross profit usually realized on the sale of total production of this type. It will be recognized that this latter procedure is one that frequently is accorded joint products.

Concerning the problem of **inventory pricing for joint products**, Vance (Theory and Technique of Cost Accounting) states:

> This is usually solved by apportioning cost to the products in proportion to their market value. A product which contributes 40 percent of the market value of the joint products is charged with 40 percent of the joint cost. This solution . . . is realistic because it results in showing the same rate of gross profit on each product as far as joint costs are concerned.

Under alternative method 3, the "loss in value" will be the difference between the cost so allocated and the accumulated cost up to the point of spoilage. (For a detailed discussion of methods of allocating joint costs, see section on Joint Costs.)

Treatment of Normal Spoilage. Where the "loss of value" of spoiled units is to be regarded as cost of producing satisfactory units, there are two methods for making this cost allocation. According to Neuner (Cost Accounting) these are: ". . . The loss due to spoilage may be charged to the production order on which the spoilage occurred, or the spoilage loss may be charged to manufacturing overhead control and thus spread over the cost of all jobs." The choice between the two alternatives is on the basis of whether or not the spoiled units are created as a result of producing units to fill a special order or are originated in the manufacture of products ordinarily manufactured on a mass production basis.

If the loss due to spoilage is to be charged to the production order on which it originated, an entry must be made to remove the "cost" allocated to spoiled units from work in process and from the related subsidiary cost records. The effect of such removal is to leave the "loss" as a cost of the particular job on which the spoiled units originated. The entry to accomplish this would be:

Spoiled Goods Inventory	$........	
Work in Process		$........

If the loss due to spoiled units is to be spread over all units produced, this may be accomplished by including the estimated spoilage losses in estimated overhead when determining the overhead rate. The rate so derived has in it an element of spoilage loss, and when used to charge overhead to jobs, spreads spoilage loss over all jobs.

Where the loss is to be spread over all units by including an estimate of "spoilage loss" in the determination of the burden rate, the following entry would be made:

Spoiled Products	$........	
Factory Overhead	$........	
Work in Process		$........

(For a discussion of accounting for units lost in process industries, see section on Process Cost Systems.)

ACCOUNTING FOR DEFECTIVE UNITS. Blocker and Weltmer (Cost Accounting) take the position that "defective work is to be distinguished from spoiled work. The former is work in which there is some imperfection which can be brought up to standard by additional materials and labor, while the latter cannot be reconditioned and the units must be sold either as scrap or as second- or third-grade products." Basically, the problem of accounting for defective units is concerned with accounting for **rework costs.**

If the number of units requiring rework is large and the rework costs are substantial, it may be desirable to set up a **salvage department** as a part of the factory organization. Bennett (Standard Costs: How They Serve Modern Management) states: "If the product is a critical one and rejections at inspection are relatively heavy, a salvage department should be established. This department will control the rejected work, salvage all items possible, and account for quantities salvaged and scrapped."

As in the case of spoilage, it may be desirable to distinguish between **normal** and **abnormal** defective units on the basis of whether they appear as an inevitable consequence of production or because of some unusual event such as a fire or earthquake. The rework cost of defective units of the latter type would be regarded as a loss and closed directly to profit and loss. If defective units appear as a normal consequence of productive activity, however, the rework costs are typically regarded as a cost of producing satisfactory products.

Treatment of Rework Costs. The disposition of rework costs will depend upon whether the units requiring rework are identified with a specific order for the production of a type of product not ordinarily produced or are the result of the usual type of manufacturing activity. Matz–Curry–Frank (Cost Accounting) state that:

> If the defective units are clearly identified with a numbered job order and the defects are peculiar to the job, the cost to complete the defective units should be charged to the job. If the defects occur on more or less common commodities ordinarily made in the factory, where defective units occur irregularly and the lot or job actually in process at the time is accidental, then the added cost is properly charged to manufacturing expenses.

If the defective units can be associated with a specific job and were caused by specifications or conditions peculiar to that job, the following entry will be made to record the use of materials, labor, and application of overhead to rework defective units:

Work in Process	$........	
Materials		$........
Accrued Payroll		$........
Overhead Applied		$........

The rework costs will be entered on the cost sheet related to the original job on which the defective units originated.

If defective units appear as the result of manufacture of products ordinarily produced, the rework costs will be recorded by the following entry:

Factory Overhead	$........	
Materials		$........
Accrued Payroll		$........
Overhead Applied		$........

The foregoing entries are usually prepared on the basis of **defective work reports** such as that shown in Fig. 23.

MANAGERIAL CONTROL OF SPOILAGE AND DEFECTIVE UNITS. Concerning the importance of control of spoilage and defective units, Boutin (NAA Bulletin, vol. 31) states:

> In some companies scrap control is a must if the company is to survive. In other companies scrap control is essential if they are to prosper. In all companies the

control of scrap should be foremost in the minds of not only the factory management, but the cost accountant as well. The term "scrap" as used in this paper means work spoiled in production and not residue material from manufacturing operations.

Since rework costs inevitably must be deducted from revenue, it follows that reduction in rework means a corresponding improvement in enterprise net profit.

DEFECTIVE WORK REPORT

DATE ____________________ NO. ____________

DEPARTMENT RESPONSIBLE ____________ STANDING ORDER NO. ________

NATURE OF DEFECTS ______________________________

CAUSE OF DEFECTS ______________________________

____

DESCRIPTION OF WORK TO BE DONE	DEPT NO.	COSTS INCURRED				
		MATERIAL	LABOR		MFG. EXPENSE	TOTAL COST
			HOURS	COST		

SIGNED:

Fig. 23. Report on unsatisfactory work.

Performance Standards. Where operations are of a repetitive nature and where there seemingly is a tendency for the appearance of excessive quantities of spoiled and defective units, efforts should be made to establish performance standards. Control implies that there is a standard or yardstick by which actual performance can be measured and judged. When an order received calls for producing a given number of a product not previously produced, and orders to produce like units are not expected, it may nevertheless be useful to make a careful estimate of the spoiled and defective units that are to be regarded as acceptable. Knowledge of what will be regarded as satisfactory performance may encourage employees to strive to attain the indicated efficiency level.

It is frequently a problem to secure the necessary cooperation of employees when standard performance is to be achieved. Boutin (NAA Bulletin, vol. 31) offers the following suggestions:

. . . Cooperation is made easy to obtain if the following points are stressed to the respective employee groups:

Works managers: reduced costs, more profit, quality product.
Foremen: greater efficiency, more production, personal recognition.

Employees: greater earnings, job security through better competitive position, recognition by other employees.

Performance Control Reports. Fig. 24 illustrates a type of chart which can be posted in a conspicuous place in a department and which reports the relationship of actual appearance of spoiled and/or defective units to the performance standard. The chart shows that in this particular department there is need for more effective control.

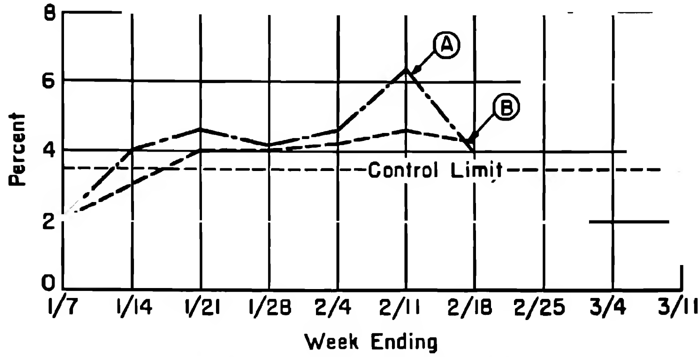


Fig. 24. Spoiled and defective units as a percentage of satisfactory units.

A report similar to that shown in Fig. 25 should be prepared for the use of the foreman of the department, with a copy going to his supervisor. Reports of this type should be summarized by departments and presented to "middle management" in the factory. (For a further discussion of reports, see section on Cost Control, Budgets, and Reports.)

REPORT OF SPOILED AND DEFECTIVE WORK

Dept.:__________ Period Covered:__________

Material Code	Description	Satisfactory Units	Acceptable (Quantity) Spoilage	Actual Spoilage	Actual OVER UNDER Acceptable	Acceptable Quantity Defective	Actual Defective	Actual OVER UNDER Acceptable	Remarks

Fig. 25. Report on unsatisfactory units.

CHART OF MATERIALS ACCOUNTING. The forms, records, and procedures used in materials accounting will vary to some extent from one manufacturing company to another. The presentation of one combination of the various possibilities, such as in Fig. 26 from Neuner (Cost Accounting), should help to demonstrate how the various elements are related to form a coordinated program for the costing of materials.

Nature of Transaction	Forms Used	Book of Original Entry	Source of Entry	Journal Form of Entry	Subsidiary Acc't Record (Perpetual Inventory Control)	Entry on Sub. Acc't Record (Perpetual Inventory Control)	Cost Record or Summary Form Used	Entry on Cost Record or Cost Summary	Source of Cost Entry
Ordering Materials	1. Purchase Requisition 2. Purchase Order				Stores Ledger Card	Memo in Ordered Section			
Receiving Materials	1. Receiving Report 2. Purchase Order 3. Creditor's Invoice	Voucher Register	Creditor's Invoice	Dr. Stores Cr. Accounts Payable	Stores Ledger Card	In Received Section cross out Memo. in Ordered Section			
Issuing Direct Materials	1. Material Requisition 2. Summary of Stores Requisitions	General Journal	Summary of Stores Requisitions	Dr. Work-in-Process—Materials Cr. Stores	Stores Ledger Card	Issued Section	Job Order Sheet	Material Section of Job Sheet	Summary of Stores Requisitions
Issuing Indirect Materials	1. Material Requisition 2. Summary of Stores Requisitions	General Journal	Summary of Stores Requisitions	Dr. Manufacturing Overhead Cr. Stores	Stores Ledger Card	Issued Section	Standing Order	Standing Order for Indirect Material	Summary of Stores Requisitions
Payment of Invoice	1. Voucher Check 2. Invoice	Check Register	Vouchered Invoice	Dr. Accounts Payable Cr. Cash					
Direct Materials Returned to Stores	1. Returned Material Report 2. Summary of Returned Material	General Journal	Summary of Returned Materials	Dr. Stores Cr. Work-in-Process—Materials	Stores Ledger Card	Received Section or in RED in Issued Section	Job Order Sheet	Entry in RED in Material Section of Job Sheet	Summary of Returned Material
Indirect Materials Returned to Stores	1. Returned Material Report 2. Summary of Returned Material	General Journal	Summary of Returned Materials	Dr. Stores Cr. Manufacturing Overhead	Stores Ledger Card	Received Section or in RED in Issued Section	Standing Order	In RED Standing Order for Indirect Material	Summary of Returned Material
Materials Returned to Vendor	1. Returned Shipping Report	General Journal or Voucher Register	Returned Shipping Report	Dr. Accounts Payable Cr. Stores	Stores Ledger Card	Issued Section or in RED in Received Section			
Inventory Adjustment Physical Less than Book	1. Stores Inventory Report	General Journal	Stores Inventory Dep't. Memo.	Dr. Manufacturing Overhead Cr. Stores	Stores Ledger Card	Issued Section	Standing Order	Standing Order for Inventory Adj.	Stores Inventory Dep't. Memo.
Inventory Adjustment Physical More than Book	1. Stores Inventory Report	General Journal	Stores Inventory Dep't. Memo.	Dr. Stores Cr. Manufacturing Overhead	Stores Ledger Card	Received Section	Standing Order	In RED. Standing Order for Inventory Adj.	Stores Inventory Dep't. Memo.
Cost of Finished Parts Manufactured	1. Cost Memo. 2. Summary of Cost of Finished Product	General Journal	Summary of Cost of Finished Product	Dr. Finished Parts—Stores Cr. Work-in-Process—Material Cr. Work-in-Process—Labor Cr. Work-in-Process—Manufacturing Overhead	Stores Ledger Card Finished Parts Stores	Received Section	Job Order	Summarize Finished Job Orders	
Issuing Finished Parts for Further Use in Production	1. Material Requisition 2. Summary of Finished Parts Requisitioned	General Journal	Summary of Material Requisitions	Dr. Work-in-Process—Material Cr. Finished Parts—Stores	Finished Parts Stores Ledger Card	Issued Section	Job Order	Material Section of Job Sheet	Summary of Material Requisitions
Placing Scrap Material in Storeroom	1. Scrap Report 2. Summary of Returned Material	None	Summary of Returned Material		Stores Ledger Card	Received Section Quantity Only	Job Order	In RED—Material Section of Job Sheet	Summary of Returned Material
Spoiled Work (Material Cost)	1. Spoiled Material Report 2. Summary of Spoiled Work	General Journal	Summary of Spoiled Work	Dr. Stores (scrap value) Dr. Manufacturing Overhead (original cost less scrap value) Cr. Work-in-Process—Material (original cost)	Stores Ledger Card	Received Section	Job Order Standing Order	1. Standing order for Loss on Spoiled Work 2. In RED. Material Section	Spoiled Work Report

Fig. 26. Summary and analysis of materials accounting under a cost system.

SECTION 6

LABOR COSTS

CONTENTS

CONTENTS (*Continued*)

SECTION 6

LABOR COSTS

Definitions and Classifications

LABOR COSTS DEFINED. The total labor cost incurred by a company includes four separate elements: **direct labor** expended on the completion of the company's products; **indirect labor** costs not expended directly on the completed products but necessary for production; **labor losses,** such as waiting time and machine delays; and **labor-related costs,** such as premium pay, holiday and vacation pay, payroll taxes, and similar forms of supplementary wage. Labor costs should not be restricted to the **base pay** earned by employees but in addition should include all **premiums** and **bonuses** and all labor-related costs connected with maintaining the labor force.

From a management and accounting standpoint, all the elements of labor cost should be considered as an integrated cost area. Matz–Curry–Frank (Cost Accounting) outline the labor cost as follows:

> Fundamentally, a labor cost consists of the hourly rate, the daily or weekly wage, or the monthly salary of the employees In addition to the base pay, generally based on a 40-hour work week, other elements enter into the labor cost. Factors such as overtime earnings, premium pay, shift bonuses, production incentives, vacation pay, apprenticeship or trainee costs, and pensions constitute other types of labor costs besides the base pay In addition to these elements, labor cost may include paid holidays; unemployment compensation; old-age and survivor's benefits; hospital and surgical benefits for employees and their dependents; and even free lunches. The measure of cost to keep an employee at work an hour or a day must include all of these elements where they exist.

DIRECT LABOR DEFINED. For cost accounting and control purposes, it is necessary to differentiate between direct labor indirect labor, and labor-related costs. This differentiation facilitates **product costing** and the measurement of **labor efficiency.** The general rule is that direct labor is labor spent in the actual production of the company's finished product or is labor immediately identifiable with product costs. It must be economically feasible, however, to associate a labor cost with units produced before treating that cost as direct. This concept is applicable not only to job lot costing but also to any labor identified with a process, such as melting, dyeing, or galvanizing. Blocker and Weltmer (Cost Accounting), in discussing process cost accounting, state: "In accounting for labor, the important consideration is the identification of each worker with the processes benefiting from his labor."

Historically, direct labor has been a separate labor element only in **job-order cost** techniques and the distinction between direct and indirect labor is less pronounced and even sometimes completely absent in companies characterized by **continuous process** manufacturing. NAA Research Series No. 32, Account-

ing for Labor Costs and Labor-related Costs, provides a definition of direct labor that covers both job order and process cost systems:

> Direct labor cost is that portion of wages or salaries which can, as a practical matter, be identified with and charged to a single costing unit. In accounting for direct labor cost, source records (e.g., time cards) are coded by departments or cost centers in order that labor costs may be accumulated separately for each department or costing center. Since the department or cost center is here the costing unit, the resulting costs may be termed direct departmental or direct cost center labor cost. The latter term is generally applied to labor in departments characterized by continuous processing or highly mechanized operations. Within each cost center, labor costs are, in so far as practical, identified with individual units or products or job orders. This is the direct labor cost of the product or order.

Labor may be classified as direct when (1) there is a direct relationship to the product through a process or a costing unit; (2) the labor cost may be measured in light of this relationship; and (3) the labor cost is sufficiently material in amount. In most companies the ultimate and practical criterion for classifying labor as direct is whether the work performed by the worker can economically be identified with the product, and the distinction between direct and indirect labor sometimes becomes a matter of expediency.

INDIRECT LABOR DEFINED. Indirect labor costs are those which are not identifiable with, or incurred directly in, the production of specific goods or services but are applicable to production activities generally. Indirect labor consists of the labor costs in **service departments**, such as purchasing, engineering, and timekeeping; **labor costs** of certain workers in the producing departments, such as foremen, material expediters, and clerical assistants; and **auxiliary labor**, such as for storeroom, factory office, and maintenance.

The following definitions of indirect labor taken from replies received in a survey by a Research Project Committee of the National Association of Accountants (Research Series No. 32, Accounting for Labor Costs and Labor-related Costs) represent company practice in defining indirect labor:

1. All labor which cannot be predetermined accurately with respect to the part number produced. Whereas direct labor is specified on the manufacturing routing both as to type and amount, and actual direct labor time is charged to a direct labor account, indirect labor is generally specified in departmental budget and standard rate sheets, both as to type and amount.
2. Work which is not identifiable with, or incurred for, the production of specific goods or services but is applicable to production activities generally. Primary factory accounts are used to show in detail all hourly and salaries classifications.
3. Nonsupervisory labor expended in support and maintenance of production operations, such as floor help, oilers, inspectors, and shippers. Can include machine adjusters.
4. All hourly and salaried plant employees except those classed as direct labor
5. Two major classifications of indirect labor are maintained:
   a. Departmental control accounts include office clerks, cost accounting, production planning and control, time study, sweepers and oilers, materials handling, service employees, inspectors, group leaders, stores, set-up.
   b. Management control accounts cover general supervisory personnel, engineering, etc.
6. Three divisions of indirect manufacturing labor are maintained:
   a. Variable expense labor, which is broken down in considerable detail and covers those activities which are tied closest to production and where the work force can be increased or decreased with changes in production volume.

b. Sweeping, cleaning, moving materials, oilers, maintenance.
c. Fixed expense labor, consisting of the works staff, engineers, firemen, grounds keepers, watchmen, and inventory work.

Classification of Indirect Labor. The classification of those labor costs which cannot be associated directly with units of production should reflect the **type of work performed.** Since different manufacturing methods and different organizational patterns are in effect within the various industrial groups, there can be no set classification of indirect labor. In addition, the preferences and policies of management will affect the classification. NAA Research Series No. 32, Accounting for Labor Costs and Labor-related Costs, illustrates a typical classification of indirect labor costs, with three broad groupings and related subgroupings, as follows:

Service groups

1. Cafeteria help.
2. Coal, oil, ash handling.
3. Elevator operators, crane and industrial operators, trucking, and chauffeurs.
4. Janitor service, area and machine cleaning, grounds.
5. Laundry help.
6. Maintenance of plant and equipment.
7. Materials, handling, receiving, storage.
8. Oilers, beltmen.
9. Steam, electric power, water, compressed air.
10. Storeskeepers, tool crib attendants.
11. Tool and die maintenance.
12. Utility gang.

Supervisory, control, and engineering groups

13. Plant management.
14. Foremen, assistant foremen, working foremen on less than 50% production, clerks, stenographers.
15. Production planning and control, expediters, dispatchers, tool and drawing chasers.
16. Industrial engineering, time study, standards.
17. Industrial relations, personnel, employment department.
18. Medical and dispensary.
19. Cost accounting.
20. Purchasing.
21. Order and billing.
22. Mechanical and electrical product engineering, drafting.
23. Tool design.
24. Metallurgical and other laboratory help.
25. Traffic.
26. Quality control.
27. Plant protection.
28. Timekeeping.

Excess direct manufacturing labor groups (some charged as direct labor)

29. Excess labor. (This account reflects the variation between productive wages payable and the standard labor cost of the production of these employees)
30. Re-operating labor. (The cost of repairing and reconditioning of product.)
31. Downtime. (Idle time of production operators.)

A standing **expense order number** is assigned to each subdivision, and lists of these numbers are posted throughout the plant. Through these numbers indirect workers know how to charge their time.

The classification of indirect labor accounts should be devised so that control over these costs may be maintained. The number of detailed indirect labor accounts used should be large enough to prevent unlike labor costs from being merged, and yet should be few enough to keep clerical costs to a minimum. Each indirect labor classification should contain **cost elements** which may be used to determine the efficiency or inefficiency of a group of related or closely integrated indirect laborers.

Codes for Indirect Labor. Indirect labor accounts should be coded in order to faciliate the distribution of charges thereto and to aid in the interpretation of these costs. Heckert and Kerrigan (Accounting Systems) state that the use of an adequate coding system will:

1. Help locate accounts quickly.
2. Reduce time for writing the identity of accounts.
3. Aid in classifying transactions
4. Aid the memory.
5. Facilitate mechanical sorting.
6. Allow for adding or dropping accounts.

Each subdivision of indirect labor should be assigned a **code number or letter,** and this may be preceded by a departmental, process, or cost center code number or letter, if desired. Thus the excess direct manufacturing labor costs in the preceding list of indirect labor accounts could be identified as applicable to the fabrication, machining, and galvanizing departments, as follows:

5300 Fabrication Department

5329 Excess Labor
5330 Re-operation Labor
5331 Downtime

5400 Machining Department

5429 Excess Labor
5430 Re-operation Labor
5431 Downtime

5500 Galvanizing Department

5529 Excess Labor
5530 Re-operation Labor
5531 Downtime

For a detailed discussion of classification and coding, see section on Cost Classifications.

LABOR-RELATED COSTS DEFINED. The base pay of employees is considered either direct or indirect labor, and all other costs incurred in connection with maintaining the labor force are considered labor-related. NAA Research Series No. 32, Accounting for Labor Costs and Labor-related Costs, has defined the costs that should be considered labor-related:

> Labor-related costs are those costs related (a) to the basic cents-per-hour wage or dollar-per-month salary paid to employees, or (b) to the number of employees on the payroll. Such costs include both amounts paid directly to employees in addition to their basic wage or salary and nondirect costs incurred by the company. Among the direct payment items are premium payments for time worked, payments for time not worked, separation payments, and unfunded pensions. Nondirect payment costs include such items as employee welfare and social security costs, employment administration costs, and workmen's compensation insurance premiums.

All costs other than the base wage should be considered labor-related, if incurred in connection with **employee compensation**, whether payment is made directly to the employee or to someone else on his behalf, whether payment is made currently and in cash, or indefinitely deferred until retirement or death.

SEGREGATION OF LABOR-RELATED COSTS FROM OTHER INDIRECT COSTS. Because of the size and growing number of labor-related costs, such as pensions, holiday pay, vacation pay, payroll taxes, group insurance, supper money, and uniforms, it is important from the standpoint of **product costing** that these labor costs be properly allocated to units of production. The Economic Research Department of the Chamber of Commerce of the United States over a period of many years has conducted a series of biennial studies (Fringe Benefits) which has shown a continual upward trend in labor-related costs. For the 1,020 companies covered, the average payment for so-called fringe benefits was 21.8% of payroll, 47.4 cents per payroll hour, or $981 per year per employee in a recent year. Correct accounting treatment of this large cost element sometimes necessitates a separate allocation of labor-related costs to products.

Lawrence (Cost Accounting, revised by Ruswinckel) states that:

> Certain of the costs included in this section, such as payroll taxes, lay-off benefit plan, and provision for vacation pay, are so closely related to labor costs that it might be sound to consider them as a second type of indirect cost separate from other indirect costs. If this were done, it would be necessary to create a second indirect control account for the "fringe" labor costs, estimate these costs for the coming year, determine a special rate for the distribution of such costs, and then "apply" this rate to wherever the labor dollars were distributed.

The **distribution basis** for this special class of indirect costs may be (1) the number of employees, (2) direct labor cost, or (3) direct labor hours. Use of any one or a combination of these bases will normally provide a proper relationship between labor, production, and labor-related costs.

DIFFICULTY IN DISTINGUISHING BETWEEN DIRECT AND INDIRECT LABOR. The distinction between direct and indirect labor is sometimes difficult to establish. Where fully **automatic machinery** is used, the worker becomes in effect a machine tender. The machine alters the size or shape of the product, while the worker merely feeds the machine at intervals and makes minor adjustments. For example, the question may be raised as to whether a worker at a modern loom in a textile plant is a weaver (direct labor), a machine adjuster (direct labor), or a repairman (indirect labor).

Modern production technique has forced a reconsideration of what constitutes direct labor. It is clear that if a man is tending a productive machine, his labor is as direct as the labor of one producing goods manually. Frequently **trade terminology** may influence the classification. In the preceding example, the worker may be a weaver or a machine tender, according to trade terminology, and in both cases be a direct laborer; but if he is a repair man or set-up man, he may be classified as an indirect laborer.

A labor item may be direct in nature but for practical reasons may not be charged directly to a given product, being prorated as direct labor over several products or even treated as indirect labor. Instances of such borderline cases are spray painting, inspection, and short operations.

Spray painting can, in some instances, be easily identified with and charged to specific jobs, but in many cases the spraying is done on a conveyor belt with items from various jobs being sprayed as needed. In the latter case, to charge the paint-spraying labor directly to the separate jobs may entail too much clerical

detail. and this labor cost should therefore be allocated to the various jobs on some equitable basis.

Inspection labor may be considered direct labor or indirect labor, depending upon the circumstances. It is often considered direct labor in cases where each unit must be tested or measured to ascertain that the product meets predetermined specifications, as in the manufacture of drugs. where each item must be tested to guard against error. Inspection labor should, in other cases, be considered indirect labor, if the inspection is done on an intermittent or selective basis. If the inspector divides his time between two or more departments or jobs, proration of his wages may be accomplished more easily by treating them as indirect wages than by attempting to make a direct allocation through time tickets or time cards.

Short operations, which require a relatively small amount of time to complete, such as buffing, scouring, and polishing, may be treated as indirect labor if the operation takes less time than the **unit time** employed in labor accounting. If in a given plant the minimum unit time is 15 minutes, an operation consuming less than that amount should be classed as a short operation. Proration of the labor cost of these operations may in some cases be best accomplished through allocation as indirect labor.

IMPORTANCE OF DISTINCTION BETWEEN DIRECT AND INDIRECT LABOR. Direct labor should be segregated from other labor costs as much as is feasible in order to provide a more accurate product cost and to provide control over labor costs. The distinction between direct and indirect labor costs is necessary also because **direct labor efficiency** is measured by the number of acceptable units completed, while the efficiency of other types of labor frequently has little relationship to the number of units produced. Therefore, in the measurement of the efficiency of a particular worker, group of workers, or a department, their labor must be divided, so far as is practicable, into direct and indirect elements.

Another reason why proper segregation between direct and indirect labor costs is important is that **manufacturing overhead** is most frequently applied on the basis of direct labor cost or direct labor hours. Unless the distinction between direct and indirect labor is clearly made and consistently followed, serious errors result in the **overhead allocation.** Thus, under a job-order method of costing, failure to treat direct labor as such not only reduces the labor cost used as a basis for applying overhead but also increases the total overhead which must be applied.

Heckert and Willson (Controllership) state that in controlling direct labor costs, as with other costs of manufacturing, the ultimate responsibility must rest on the supervisors, but they must be given assistance through accounting procedures that accurately distribute labor costs and provide significant labor classifications which serve as a basis for informative labor cost analyses.

MANAGEMENT'S INTEREST IN LABOR COSTS. Management is primarily interested in labor cost accumulation and analysis because they serve as a basis for:

1. Control over labor costs.
2. Managerial decisions.
3. Inventory costing and profit determination.

The various administrative divisions of a plant naturally place varying emphasis on these points. Top executives are primarily interested in total labor

costs, the ratio of labor costs to total costs, and changes in the labor ratio. These data serve as bases for decisions involved in wage negotiations and the coordination of operating divisions. Major operating executives, such as the vice-president in charge of manufacturing or the plant superintendent, require additional detail, including costs by jobs, processes, operations, and departments. Production control men and shop foremen need detailed figures applying to their particular jurisdictions and giving information as to how each figure compares with budgetary or other operating standards.

Basis for Control. Adequate control of labor costs involves more than the reduction of these costs; it involves verification of the efficiency of labor operations and includes the problems of maintaining **adequate compensation levels,** maintaining **product quality** in accordance with predetermined standards and holding the **volume of production** to optimum levels.

Control over labor costs originates with a comparison of actual labor costs with some form of predetermined standards. The resulting variances are then analyzed as to causal factors. Even the most detailed and accurate recording of labor costs will not ensure control over labor costs unless management applies some **standard of performance** as a measure of the efficiency and effectiveness of that labor and follows up on variances from that standard. (See sections on Setting Standard Costs, and Analysis and Control of Standard Cost Variances for a detailed explanation.)

Basis for Management Decisions. Many of the decisions that management must make are based upon cost data. Vance (Cost Accounting) lists some of these major decisions as follows: price setting, selection or elimination of product territory, customers, salesmen, or methods of selling, purchase of new plant or equipment, location of plant, and choice between making or buying an article. To make such decisions, management must have adequate labor cost data to determine the **fixed** and **variable** portions of labor, the additional or **marginal labor cost** to produce certain articles, and **alternative labor cost** data. Much of these data is not set out in regular labor cost reports and must be compiled through separate cost studies. The labor records should be so devised that management may have these data compiled as accurately and rapidly as possible when the need for them arises.

Basis for Inventory Costing and Profit Determination. The costing of inventory and the resulting determination of profit require that products be costed by assigning direct labor and an equitable portion of indirect labor and labor-related costs to products. Direct labor, by definition, is assigned directly to products. Indirect labor and labor-related costs should be assigned to products on an equitable and practicable basis. In writing on the application of overhead, Matz–Curry–Frank (Cost Accounting) state that while many bases are available for allocating these costs, clerical practicality and economical application are also factors to be considered. The ultimate objective of any basis selected for the allocation or application of indirect costs should be to charge a job or product with the amount that most closely corresponds to the actual costs of the job or product.

Timekeeping for Cost Purposes

PURPOSE OF TIMEKEEPING. Timekeeping records supply the necessary basic data for the payroll department to compute and prepare the payroll. These records are also the basis whereby the cost accounting department may

charge direct labor costs to jobs or processes and allocate or apply overhead where the basis of the application is time, such as labor hours or machine hours. Timekeeping thus has two distinct aims:

1. To accumulate data used as a basis for preparation of the payroll.
2. To accumulate data used as a basis for distribution of labor costs to jobs, processes, departments, or cost centers.

Daily work reports, attendance registers, time tickets, or other devices are used to accumulate **time records** for payroll and labor distribution purposes. The data on these records should be sufficient to satisfy the following basic purposes of timekeeping, as set out by Lang–McFarland–Schiff (Cost Accounting):

1. For payroll purposes:
   a. To show the number of hours worked.
   b. To disclose absence or tardiness.
   c. To measure overtime for which extra pay may be due.
   d. To provide evidence of compliance with legal requirements.
2. For cost purposes:
   a. To know the quantity of work done on each job.
   b. To know the cost of the work done.

In Fig. 1, Vance (Theory and Technique of Cost Accounting) gives an over-all view of the organization for labor cost control—the functions performed, the documents and records prepared, and the uses made of the documents and records.

WHERE AND BY WHOM TIME IS KEPT. The time spent by a worker on a particular task may be kept by himself, by his foreman, by a **traveling timekeeper,** or by a **stationary timekeeper.** No universal rule can be set as to who should keep time, since individual circumstances differ. Cook (NAA Bulletin, vol. 40) underlines the importance of **accurate timekeeping** to prevent unscrupulous, inefficient supervision from covering up its inefficiencies by charging excess labor time to rework, training time, machine downtime, or to parts not covered by standards.

In small plants the foreman or the individual operator may do the timekeeping. This arrangement has three distinct **disadvantages:** (1) The operator or foreman may manipulate the reporting of time from job to job to cover inefficiencies or errors. (2) The operator or foreman may be inclined toward carelessness in timekeeping or may neglect this duty in preference for his productive assignments. (3) Valuable productive time is lost and mental distraction to the workers results from having them keep their own time.

If the individual operators keep their own time, the foreman should check the time tickets or work reports at the end of each day. This enables him to watch the accuracy of their timekeeping and also gives him a measure of the efficiency of each of his workers.

The source of all labor distribution entries is either a time ticket specifying the number of hours or pieces, or both, or a mechanically printing **elapsed-time clock,** which automatically stamps on a specially prepared timekeeping record the elapsed time in hours and minutes spent on a particular operation or unit.

HOW TIME SHOULD BE KEPT. Timekeeping for labor cost distribution may be accomplished by means of **work reports** or **time tickets.** These devices record the time spent by each employee on each job or process, and time on these records must balance with the time used for payroll purposes.

LABOR RECORD KEEPING FUNCTIONS AND RECORDS

Function	Document or Record Prepared	Other Document or Record Used in Preparation	Basic Uses of the Document or Record: Payroll Accounting	Labor Cost Accounting	Compliance with Legislation
Hiring	Employee data card	—	√		√
	Withholding exemption certificate	—			√
Recording time worked	Attendance time card	—	√		
Recording work done	Time card, time report, or piece work ticket	—	√	√	
Summarizing payroll (recorded in voucher register)	Payroll sheet	Attendance time card or piece work tickets	√		
Paying employees (recorded in check register)	Payroll check	Payroll sheet	√		
	Statement of earnings and deductions				√
Summarizing and posting labor cost (recorded in general journal)	Labor analysis sheet or Payroll Distribution Journal	Job time cards, time reports or piece work tickets		√	
Summarizing individual earnings	Individual earnings record	Payroll sheet			√
Accruing and paying payroll taxes (recorded in general journal, voucher register and check register)	Tax returns	Individual earnings records			√
	Information returns				√

Fig. 1. Organization for labor cost control.

Clock cards are frequently used as timekeeping records for payroll purposes. These cards should be placed in racks, the "out" cards on one side of the clock and the "in" cards on the other side. These **card racks** should be under the supervision of a responsible person who sees that only one card is handled by each employee and that there is no back-tracking or repeating. The racks should be located at a convenient distance from the clock recorder so that employees may take time to select or file their cards without obstructing and delaying the line of registrants. Some companies keep the "out" rack by the time clock but maintain "in" racks within each department so that the foreman many ascertain whether he has a full working force.

A survey of how 126 companies record employee time by American Business (vol. 27) shows that the question of whether or not to abolish the time clock and to have employees keep their own time is a subject of lively discussion among personnel executives. Sixty percent of the respondents in this survey report that their employees accept the use of the time clock and that no problems are involved while 12% report that the time clocks are not well received. Over 50% of the executives responding believe that the punched time card is the best method for keeping time records.

A **floor check record** sometimes serves as a useful aid in determining that time paid for is actually worked. This record should indicate that each employee paid was on the job and that the number of hours entered were actually worked. It may cover a complete pay period or only one day. An ordinary check mark may be used in the morning to indicate that the employee is on the job, and a stroke made through the mark in the afternoon when the employee is checked again. At the end of each day the floor check record is compared with the clock card, and the number of hours worked is inserted on the record. It is then forwarded to the payroll department.

Most companies match the time tickets or work reports with in-out clock cards, **attendance registers,** or floor check reports at the end of each day, week, or pay period, in order to ascertain that all time which must be paid for is recorded as assignable to some cost account. The total time worked during each day, as shown on a clock card or attendance register, is easily compared with a daily work report for each employee, but the comparison is more difficult when individual time tickets are used and each employee has several time tickets during the course of each day.

DUTIES OF TIMEKEEPER. The specific duties of the timekeeper vary among companies, and frequently the timekeeper is assigned tasks in addition to that of timekeeping. However, his primary duties are (1) timekeeping or attendance, for payroll purposes; (2) timekeeping of work performed and production realized, for labor cost distribution purposes; and (3) timekeeping for purposes of satisfying the requirements of the Fair Labor Standards Act (wage and hour law). Gillespie (Accounting Systems) describes the duties of the timekeeper as follows:

Attendance timekeeping:

1. Racking the attendance cards, usually simultaneously with picking up the cards for the previous pay period.
2. Supervising the clock punching.
3. Auditing the clock cards, including locating each man who has punched in, spot-checking periodically to assure that each man who is punched in is still on the job, and ascertaining that each worker is performing work assigned to him.

4. Computing total hours and footing the clock cards or attendance registers.
5. Reporting time to the payroll department.
6. Miscellaneous duties, such as supervision of lockers and badges.

Labor and production timekeeping:

1. Issuing job tickets.
2. Visually checking periodically to ascertain that each worker is still on the job assigned him.
3. Balancing time on each job or process against attendance time, and making necessary adjustments.
4. Accumulating actual hours for each operation or job, which may be compared to standard or budgeted hours.
5. Extending production figures by standard man-hour figures to obtain standard hours.
6. Reporting piecework production by individuals, teams, or departments.
7. Miscellaneous duties, such as preparing special reports for clothes-changing-time pay, clothes allowances, tool-sharpening pay, working through lunch hour, and supper pay.

The Fair Labor Standards Act requires that attendance records be maintained for each employee, including the total hours worked each day. Ordinarily the attendance and labor records necessary to satisfy payroll and cost department needs will meet these **governmental requirements.**

LOCATION OF TIMEKEEPERS. Timekeepers should be located as near as possible to the center of their activities, and the nature of the duties assigned to the timekeeper will determine the best location. A **traveling timekeeper** is one who moves around the department more or less continuously during the day, noting when workers change jobs and recording the respective start and stop times. A **stationary timekeeper** has a definite work place, and the employees go to his desk to report start-and-stop times, changes in jobs, and transfers to other departments. A stationary timekeeper should make the rounds of the machines in the morning as soon as the whistle blows, after lunch, and several other times during the course of the day, to be certain that workers have not changed jobs without reporting to him. During most of the day he is at his work place.

The nature of production in each plant will determine whether stationary or traveling timekeepers are more efficient. If changes in jobs or processes are relatively few and consume a comparatively long span of time, the timekeeper should be stationary. This will permit maximum use of the timekeeper's time and yet will not detract unduly from the workers' production time. If, on the other hand, jobs or processes are frequently changed, the timekeeper should travel throughout the plant. The use of traveling timekeepers makes it possible for production workers to remain at their jobs and prevents the congestion that would result around a stationary timekeeper's desk.

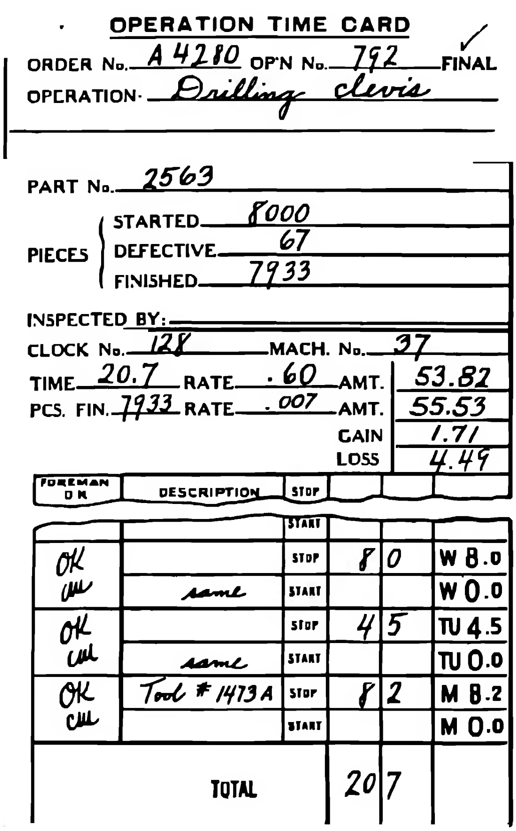
TIMEKEEPING DEPARTMENT. In most concerns timekeeping is handled by a regular timekeeping department, established as a separate unit. This is a desirable arrangement when there is a large number of employees or a considerable variety of operations or classes of labor.

Because of the close relationship of timekeeping and cost accounting, the **chief accounting officer,** whether his title be controller, auditor, or accountant, has a definite responsibility for timekeeping methods and results. On the other hand, the factory superintendent or plant manager, and his foremen, have a responsibility for the performance of their department and their men, and they must see that proper accounting is made for all labor under their supervision. This dual

responsibility of both accounting and production officials leads to two types of timekeeping organization:

1. The timekeeping function may be entirely under the direction of the chief accounting officer's organization.
2. The timekeeping function may be under the supervision of the plant manager

When timekeeping is a function of the accounting organization, the foreman should initial all tickets (Fig. 2). Care should be taken in such cases, however, to ensure that these reports are really examined before being signed and not casually approved.


OPERATION TIME CARD ✓

ORDER No. A 4280 OP'N No. 792 FINAL

OPERATION· Drilling clevis

PART No. 2563

PIECES STARTED 8000

DEFECTIVE 67

FINISHED 7933

INSPECTED BY:

CLOCK No. 128 MACH. No. 37

TIME 20.7 RATE .60 AMT. 53.82

PCS. FIN. 7933 RATE .007 AMT. 55.53

GAIN 1.71

LOSS 4.49

FOREMAN OK	DESCRIPTION				
		STOP			
		START			
OK		STOP	8	0	W 8.0
	same	START			W 0.0
OK		STOP	4	5	TU 4.5
	same	START			TU 0.0
OK	Tool # 1473 A	STOP	8	2	M 8.2
		START			M 0.0
	TOTAL		20	7	

Fig. 2. Job order time ticket.

When **time clerks** are under supervision of the plant manager, the chief accounting officer should retain responsibility for specifying methods and procedures and periodically auditing the results. Timekeeping duties, however, should not make clerks of the foremen. The foreman's chief interest is production, and he should not be compelled to neglect supervision of production in order to supervise details of timekeeping.

The best arrangement under typical conditions in a large organization is to establish a regular timekeeping department, with time clerks responsible to a head

timekeeper or supervisor. The latter in turn is under the administrative supervision of the plant manager. Procedures are specified and spot-checked, however, by the controller or other accounting officer through his works accountant or cost department.

RELATIONSHIP OF TIMEKEEPING, COST DEPARTMENT, AND PAYROLL. The desirability of tying the cost records into the financial books of account is now generally recognized. This relationship ensures greater accuracy and completeness of the cost records and also provides a valuable **internal check** on payroll payments. Time tickets will not be overlooked or omitted from the cost records if the time recorded on them must balance in total with the payroll. Neither can the payroll be easily padded or falsified if the manipulation must be balanced by a corresponding manipulation of the detailed cost figures, which in turn must be reconciled with the inventories of goods produced.

Under one system, **dispatching** and **attendance** are part of the functions of the timekeeping department, and time from the **attendance board** in the form of in-out cards is forwarded to the payroll department for preparation of the payroll. A stationary timekeeper is used, and the time tickets and in-out cards are reconciled in total both daily and at the end of each week. After reconciliation the in-out cards become the basis for the payroll, and the time tickets become the basis for posting to the detailed job records. The completed payroll then forms the basis for determining the charges which are to be made to cost controlling accounts.

TIME TICKETS. Time tickets are the basic supporting documents for measuring the performance of workers and for preparing labor cost distributions. There are many different forms and types of time tickets, but each should be so constructed that the employee's **total working time** is detailed, showing exactly what the employee did during that time. From this detail the labor cost of products, jobs, and operations can be determined, as well as the indirect labor cost; and by comparison with standards or predetermined labor budgets, the efficiency of the worker can be determined. The **basic time ticket data** recorded should include the worker's name or employee number, the department name or number, identification of the job orders or processes on which the employee worked, the time started and stopped on each job or process, the elapsed time, the employee's pay rate, and the date. The time tickets may be handwritten or prepared by mechanical devices and should be sorted or summarized each day to accumulate the total time spent on each phase of the job or process or on each type of indirect labor. The sorting of the time tickets may be done mechanically or by hand.

Single Time Ticket for Each Payroll Period. The use of a single time ticket for each payroll period is advantageous when workers perform the same work regularly, as is the case in most continuous-process industries. The principal **advantage** of this type of time ticket is that it reduces the number of tickets that must be analyzed to make distribution of the labor costs to processes or products. Use of time tickets that cover a full payroll period, however, has the **disadvantage** of too long a time span between reconciliation of the time tickets and the attendance records.

Errors or discrepancies of the time tickets are difficult to correct after several days have passed. Also, when a single ticket is used to cover each payroll period, there may be a tendency to omit the attendance records and let

the time ticket serve for both attendance records and cost distribution. This procedure should not be followed, since it destroys the control effected by comparison of the two records.

A single ticket for each payroll period should not be used when jobs are changed frequently or employees are shifted from process to process. A variation of the scheme may be used, however, which consists of issuing a separate ticket for each order. The operator then keeps the ticket until the order is completed. Fig. 2 shows such a ticket, with a total of 20.7 hours worked. Since the work had been completed, the word "Final" was checked on the ticket. When this method is used, all tickets must be turned in at the end of the pay period, whether or not the job is finished, so that the resulting labor costs can be checked against payroll records.

Single Time Ticket for Each Day. The use of a time ticket for each employee for each day is more adaptable to companies where workers change jobs or

JOB TIME TICKET

Name James Walters

Number 169

Department 8

Clock Record	Elapsed Time		Order No.	Operation
		Stop		
		Start		
		Stop		
		Start		
W 15^{00}	.90	Stop	7490	drill
W 14^{10}		Start		
W 14^{10}	.30	Stop	1001	stand by
W 13^{80}		Start		
W 13^{80}	3.40	Stop	7490	set up and drill
W 10^{40}		Start		
W 10^{40}	2.40	Stop	7431	drill
W 8^{00}		Start		

Order No.	Hours	Rate	Cost
7431	2.40	3.00	720
7490	4.30	3.00	12.90
1001	.30	3.00	.90
TOTAL	7.00	3.00	21.00

Fig. 3. Employee's daily time ticket, showing cost distribution.

processes several times during the day. This procedure permits a **daily check** of the labor distribution with attendance time, resulting in immediate correction of errors, as well as an even **work load** for the clerical personnel who extend and post labor data to the detail records.

Fig. 3 illustrates a daily time ticket for a single employee. Both the job number and the operation performed are entered by the timekeeper, and the start-and-stop time is punched on a time clock. Note that the time used is **Continental time**, which numbers the hours of the day from 0 to 24, and in which fractions of an hour are carried to the nearest hundred. This measurement of time facilitates the computation of time spent on each job and the labor cost of each operation. The summary of time spent on each job must be entered on each ticket at the end of each day.

Fig. 4 illustrates a variation of the daily time ticket that facilitates the summarization of time spent on each job. This form has a carbon copy which is

JOB TIME TICKET

Name____________________

No.________

Complete this section only				For office use only		
Employee No.	Order No.	Time		Hours	Rate	Cost
		Stop				
		Start				
		Stop				
		Start				
		Stop				
		Start				
		Stop				
		Start				
		Stop				
		Start				
		Stop				
		Start				

Fig. 4. Time ticket with detachable stubs.

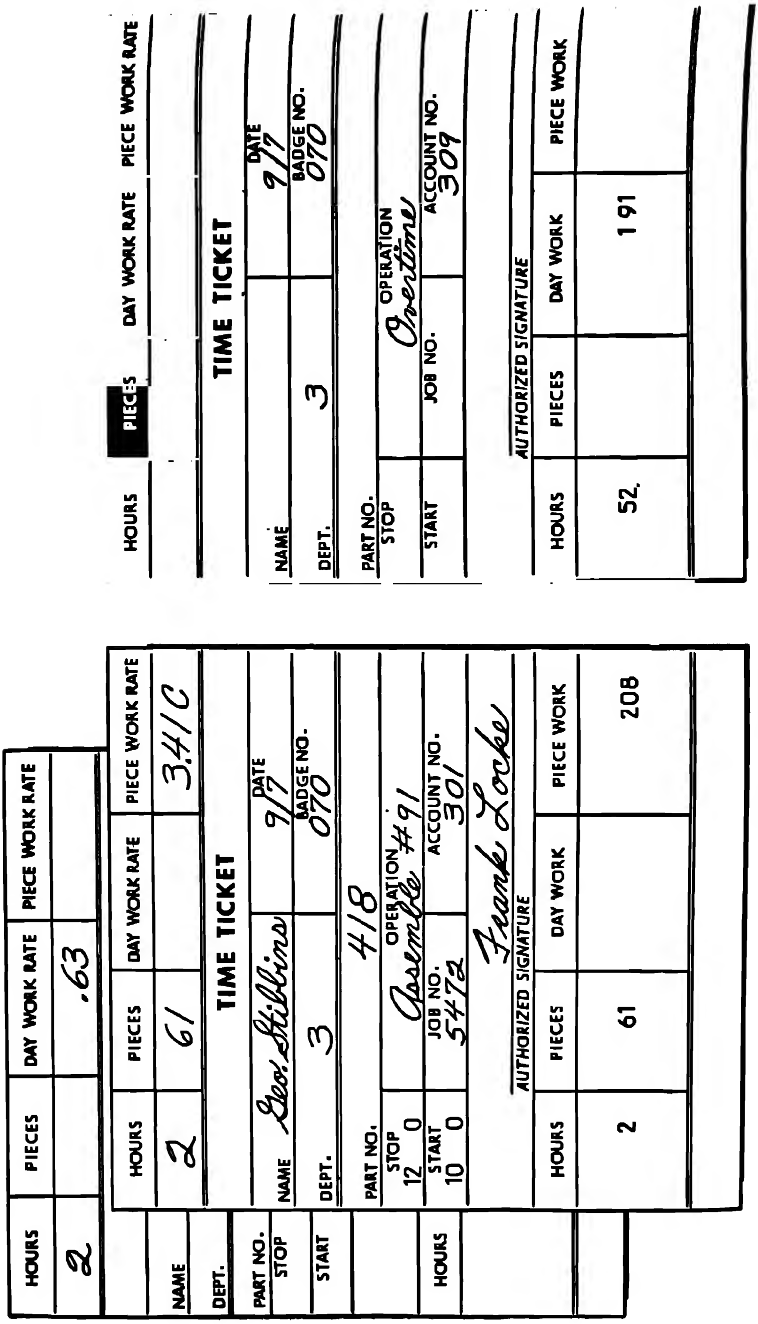


Fig. 5. Individual job time ticket.

perforated so that several stubs are prepared, one for each job worked on. At the end of the day the stubs are removed and sorted by jobs. This procedure permits a summarization of total time and total cost for each job by addition of all stubs applicable to a particular job. The original of the time ticket is not separated, remaining as the **permanent work record** of the employee.

Unit Tickets. In Fig. 5, Neuner (Cost Accounting) shows a separate ticket, sometimes called a unit ticket, issued for each job each day. Thus a worker turns in during the day as many tickets as there are jobs which he worked on. Much of the information on these tickets may be preprinted, including the job number and the operation to be performed. The bottom portion of the ticket for data on quantity and hours is filled in by the timekeeper, and rates of pay and extensions may be completed by the payroll department or cost section. If the employee has **idle time,** or **downtime,** for which there is no unit ticket, a separate ticket will have to be prepared. The use of different colors on these tickets effectively segregates them from the regular production tickets.

Gang Sheets. Sometimes a gang sheet is used to record the time of a group of employees performing related duties, and occasionally it is used for an entire department. Fig. 6 illustrates a gang sheet with each vertical column accumulating the labor cost for each job and each horizontal column accumulating the labor performed by each employee. This form of time ticket may be used in instances where the jobs do not change frequently and a relatively small number of jobs is in process at any one time.

Preprinted Time Tickets. Some concerns, upon receipt of **bills of materials** or **blueprints,** have a **time setter** prepare a time card for each operation or each job. The time card shows the time allowed for the operation, as well as the machine or group of machines on which the operation is to be performed. The time card then serves both as a **work assignment** and as a basic record of time spent on the job. This method is particularly useful when premiums are paid for exceeding the standard. Its use is similar to that of a prepared stores requisition or bill of material when a production order is prepared.

A variation of this method makes use of a set of **master plates** to cut the tickets. With each manufacturing order, the production department sends the factory an envelope containing all necessary piecework labor tickets to complete the order. These tickets show details of operations, quantity to be made, and piecework rate. The only information remaining to be entered on the tickets in the factory is the operator's number and elapsed time, and possibly particulars as to materials used. Fig. 7 is an example of such a ticket prepared on a **ticketograph.** Usually these tickets are produced with the aid of a complete master set of **addressing plates or stencils,** one plate or stencil for each direct labor operation and a set of plates for every regular stock item. When an item is to be put into production, the production department selects the set of plates for that item and prefixes an auxiliary plate showing the quantity to be manufactured and the order number, printing the labor tickets from them. By this method all direct labor operations are controlled, since no operation can be performed without one of these printed time tickets, and no handwritten time tickets are honored by the payroll department.

Combination Clock Cards and Time Tickets. Conventional methods of timekeeping call for in-out clock cards and use of separate time tickets. These two items must be reconciled periodically. When both records are combined into a

No 6944				No 6944		No 6944		No 6944		No 6944		No 6944		No 6944	
DEPARTMENT 14				DEPT. 14		DEPT. 14		DEPT. 14		DEPT. 14		DEPT. 14		DEPT.	
R. C. Rowe, APPROVED BY				JOB 201		JOB 216		JOB 230		JOB 240		JOB 248		JOB	
DATE 9-10				DATE 9-10		DATE 9-10		DATE 9-10		DATE 9-10		DATE 9-10		DATE 9-10	
GRAND TOTALS	160		392 10	20	50 60	41	94 65	18½	49 70	47	120 60	31½	72 55		
NAME AND NUMBER	HOURS OR PIECES	RATE	AMOUNT												
Joe Brown															
REGULAR TIME	8	3 00	24 00	3	9 00	2	6 00	1	3 00	2	6 00				
OVERTIME															
TOTAL															
CLOCK NO. 248															
Henry Carpenter															
REGULAR TIME	8	4 00	32 00	1	4 00	3	12 00	2	8 00			2	8 00		
OVERTIME															
TOTAL															
CLOCK NO 250															
W. C. Carr															
REGULAR TIME	8	2 50	20 00	2	5 00			2	5 00	2	5 00	2	5 00		
OVERTIME	2	3 75	7 50									2	7 50		
TOTAL			27 50												
CLOCK NO 251															
F. Smith															
REGULAR TIME	7½	2 00	15 00	3	6 00	1	2 00					3½	7 00		
OVERTIME															
TOTAL															
CLOCK NO 255															

Fig. 6. Gang sheet for job distribution and payroll.

459 13	459 13	459 13	459 13	459 13	459 13	459 13	459 13
12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,
09	01	18	04	06	12	05	5134
P FT	LABEL	FC NK	S D F CL	H BTM	MARK	BUTTON	COAT
							OFFICE
P FT	LABEL	FC NK	S D F CL	H BTM	MARK	BUTTON	COAT
MK FT	J*SLE	COL ON	FL SD	B H.	BTS ON	TRIM	COAT
459 13	459 13	459 13	459 13	459 13	459 13	459 13	459 13
12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,	12¼ 47,
02	12	09	03	14	18	01	5134
MK FT	J*SLE	COL ON	FL SD	B H.	BTS ON	TRIM	COAT
							FACTORY

Fig. 7. Preprinted direct labor ticket.

single form, reconciliation of labor charges and payroll earnings becomes automatic. Fig. 8 is an example of such a combination, the top portion of the form serving as the clock card for the day and the lower half divided into six stubs for recording job time. If the employee needs more than six stubs in any one day, additional time slips may be attached. The foreman checks the cards at the end of each day, and after the employee has punched out, he places the combination clock cards and time tickets in a locked box. They are picked up each morning by the timekeepers, who reconcile the job time with the clock time, sort the cards by departments, and forward them to the payroll department. The payroll department computes the daily wages, extends elapsed time by jobs, removes the stubs, and forwards the stubs to the costing section for posting to detail job records. The top part of the card with the in-out clock data is retained as a permanent record of the payroll department.

Abrams (NAA Bulletin, vol. 38) describes the **advantages** of the combination clock card and time ticket as follows:

> Because the cards are available to them in their departmental areas, supervisors are aided in their control of personnel. They can detect absences and lateness sooner and can adjust work assignments more quickly to compensate for the missing employees. Timekeepers find it easier to reconcile differences between total job time and hours worked because they now do this daily. There is no longer need to ask people to try to remember time data for previous days. The single card system makes it practicable to produce timely reports of absences and analyses of the reasons for the absences from the same sources from which payrolls are prepared. Also, it helps to relieve congestion at the plant entrance by eliminating the necessity for putting cards back in the card rack at the clock area both at the beginning and ending of the shift.

TIME RECORDERS. While some companies record time started and stopped on each job by a handwritten process, other companies use **mechanical recorders** to make the recording of elapsed time as error-proof as possible and to

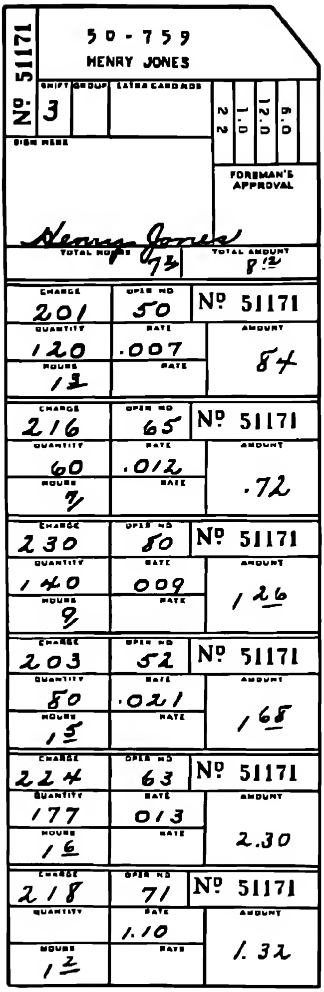


Fig. 8. Combined clock card and time ticket.

avoid juggling or miscalculation. These electrical recorders, usually in the form of time clocks, are located at various strategic points throughout the plant or in the central timekeeping department and are used to stamp the start and finish times on each job. Fig. 2 illustrates time recorded by use of a clock which stamps the day, hour, with fractions of an hour to the nearest tenth. Fig. 3 illustrates time recorded by a clock arranged to print hours of the day running from 0 to 24, with fractions of an hour to the nearest hundredth.

A further variation of the use of time recorders is the **Calculograph,** which automatically computes the elapsed time from the start to any stop time, regardless of the number of tickets in process and without causing confusion between

tickets. Fig. 9 illustrates this form of time recorder. The dial can be calibrated in tenths of an hour instead of minutes or in any fraction of an hour desired. The clock prints dials showing the exact time when the job was started and finished, as well as the time elapsed on the job.

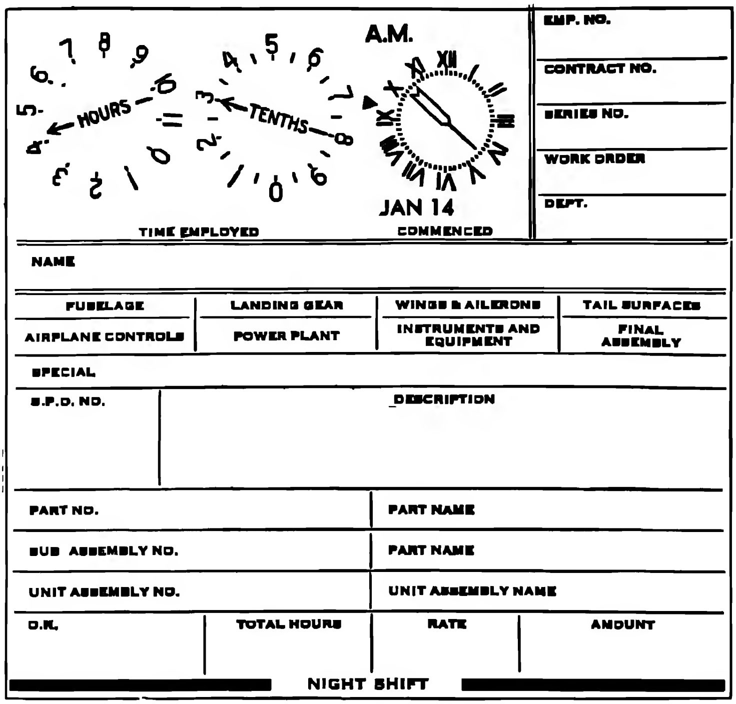


Fig. 9. Automatic elapsed time computer.

LABOR RECAPITULATION SHEET. As soon as the time tickets have been prepared and checked to the in-out cards, the labor costs indicated by the tickets must be accumulated and summarized for posting to the **detail cost records.** To facilitate the accumulation of labor costs by individual jobs when a number of employees work on the same job, a labor recapitulation sheet is frequently used (Fig. 10). This sheet accumulates the **total labor cost** for each job in the vertical columns and the **individual employee earnings** in the horizontal columns. Thus only one posting for labor cost need be made daily to any job, the labor cost for each worker is easily checked against payroll records, and the total labor costs posted to detail cost records may be checked against the total payroll. The employee's name and number and the job numbers may be prepared in advance by use of printing machines, thus reducing the clerical work of preparing the recapitulation sheet.

TABULATING LABOR CARDS WITH STANDARD COSTS. When a standard cost system is used, procedures may be employed to reduce the time spent in analysis of time tickets. Punched **tabulating cards** are often used, serv-

LABOR RECAPITULATION

Department________________ Week ending____

Employee		Job Order No.						Total
No.	Name							

Fig. 10. Labor recapitulation sheet.

ing as combined work orders and labor tickets (Fig. 11). A master set of tabulating cards is prepared for each operation involved in producing a stock item, and these cards are filed in the production, scheduling, and planning departments. When an item is to be manufactured, sets of work-order time ticket cards are cut from the master card and issued to employees as the work is to be performed. When the worker has completed the operation, the **elapsed time** is compared with the **standard time** on the cards, and only those cards on which elapsed time differs from standard time are analyzed. A complete set of these **direct labor master cards,** prepunched and interpreted, is supplied to each timekeeper for each operation performed in his department. The following information is punched on these master cards: part number, operation number, standard hours per 100 pieces, earned hours per 100 pieces, and class of labor.

DISPOSITION OF TIME TICKETS. After the time or piecework tickets have been reconciled with payroll data, they are turned over to the cost department. All such tickets are posted to the proper **shop orders** through some form of columnar **distribution sheet** or other suitable distribution technique. In many cases these tickets also show **machine hours** (see Fig. 5), which may be posted to shop orders if overhead is applied on that basis. Machine accumulation of subtotals or the use of work sheets will reduce the volume of postings to job order or process **cost sheets.** In **punched-card** installations, sorting and subtotaling can, of course, be accomplished easily by machine. Another effective and inexpensive method of quick sorting involves use of **Keysort** equipment. Grooving to obtain the desired classifications is done on a mass basis at the time the

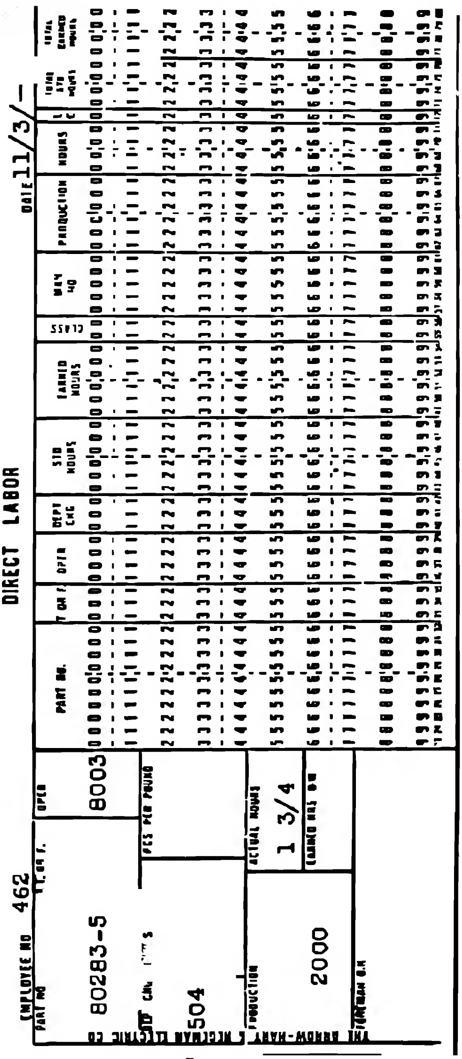


Fig. 11. Tabulating labor distribution ticket.

cards are made. A further advantage of Keysort cards is that they are still usable even if they become torn or wrinkled, and therefore they may be issued directly to workers.

After the time tickets have been sorted and totals accumulated for posting to detailed job sheets, the time tickets should be maintained in some logical arrangement—by employees, days, departments, or operations. They should be kept for a reasonable period of time, for sometimes analysis of labor costs necessitates review of the time tickets for a previous period. If the time tickets are also

combined with the clock cards for attendance record purposes, they should be kept for the length of time required by governmental regulations.

COSTING TIME TICKETS. Elapsed time spent on each job or process must be converted to dollar labor cost before being posted to individual cost sheets or job records. Time may be extended to dollar cost on the basis of the hourly rates of individual employees, at an average rate for closely associated groups of employees, or some statistical basis may be used, such as **factor hours** (see description later in this section under Use of Factor Hours in Timekeeping). Use of individual employee pay rates is the most accurate but requires more clerical effort. Use of average rates will give labor costs of reasonable accuracy when employees receive equal or nearly equal rates of pay and will require relatively less clerical work. Use of the factor hours should be limited to situations where the employee simultaneously performs several operations, possibly on several jobs.

Use of Individual Employee Rates. If individual employee rates are used, they are transcribed to the job tickets from master rate cards showing the current rate for the employee. Probably the most economical method of costing the hours on job tickets is the use of prepared tables. Such a table is illustrated here, prepared for use when time tickets are kept to the nearest tenth of an hour (Fig. 12).

Time (Tenths of an hour)	Employee Hourly Pay Rate		
	$ 2.00	$ 2 10	$ 2.20 etc.
0.1	$ 0.20	$ 0.21	$ 0.22
.2	.40	.42	.44
.3	.60	.63	66
4	.80	.84	88
.5	1.00	1.05	1.10
.6	1.20	1.26	1 32
.7	1.40	1.47	1.54
.8	1.60	1.68	1.76
.9	1.80	1.89	1.98
1 0	2.00	2.10	2.20
2.0	4.00	4.20	4.40
3.0	6.00	6.30	6.60
4.0	8.00	8.40	8.80
5.0	10.00	10.50	11.00

Fig. 12. Time ticket costing table.

Use of Average Hourly Rates. Average rates per hour are used in costing elapsed time when:

1. A number of employees at approximately the same rate of pay work interchangeably on similar operations.
2. One operation normally requires the joint efforts of a principal workman and a helper paid at a lower rate.

In the first case, if each member of a team works at $2.00 per hour, it is inefficient to price each individual ticket and then summarize the resulting dollar values. Instead the same mathematical result is obtained if the hours worked by

the group are first summarized by jobs, products, or other classifications for an entire pay period, or even for a month. At the end of that time the rate for the group is applied to the summarized totals of the hours. Even when there is a range of pay rates ($1.95, $2.00, and $2.10 per hour) for various workmen, if the operations performed by all the men are similar, there is no virtue in charging one product at $1.95 and another at $2.00 just because of the incidental assignment of a high- or low-paid man to the job. In such circumstances the hours for the group are summarized by jobs, products, etc., on one record by the cost department; the **dollar earnings** of the group are summarized for a corresponding period on another record, perhaps by the payroll department. At the end of the period the total dollars of the group, divided by the total hours of the group, produce an average rate per hour, which the cost department can then apply to the hours charged to each job or process.

The same method is applied when, for example, a workman at $3.00 per hour and his helper at $2.40 per hour work jointly at a given task. The hours of the two workers can be summarized for a week or month, and the average rate of $2.70 per hour applied to the summarized hourly totals yields exactly the correct mathematical result with much less effort. This is substantially the method followed by the General Tire Company, where employees work on **gang** or **pool operations**. The labor cost is first computed for the job as a whole, and the total is apportioned among the individual workers on a percentage basis.

The use of Keysort equipment makes possible the **prepunching** of rates into cards. Similar rates can then be sorted together and one bulk extension made. In general, developments in mechanical equipment to handle the immense task of preparing payrolls and labor distributions in large plants have brought about major changes in procedure and in the scope and extent of consolidation of operations and mechanization. Thus, for example, **labor distributions** are obtained almost automatically as a by-product of preparing the payroll and related documents on certain modern office machines.

Use of Factor Hours in Timekeeping. When an operator runs several automatic machines simultaneously, each machine is referred to as a "factor," and the hours when it is in operation are known as "factor hours." Labor hours are then computed on the basis of these factor hours. Where factor hours are involved, timekeeping methods vary as follows:

1. A single ticket is used and marked "Factor 1," or "Factor 2," etc., to indicate the number of machines operated at various times of the day.
2. Separate tickets may be issued for each machine, and each starting and stopping time indicated on each ticket.
3. In extreme cases separate tickets are made out for each machine each time there is a change in factors.

The fairest method for apportioning labor cost to production when factor hours are involved is to calculate a cost per factor hour based on a maximum or standard number of factors. For example, if an operator is expected to run three machines and is paid $2.00 per hour, the following factor-hour cost results, assuming an eight-hour day:

1. Worker's earnings per day (8 × $2.00)	$16.00
2. Factor hours (3 × 8)	24
3. Cost per factor hour (item 1 ÷ item 2)	$ .66⅔

The production of each machine is charged at the above **standard factor-hour rate.** Any deficiency in labor cost due to the failure of all machines to run full

time is charged to an **idle time** *account. In this way job costs are relieved of excess charges due to idleness of equipment. The following computation shows the resulting costs:*

	Hours Run	Product Cost	Hours Idle	Idle Time Cost
Machine No. 1	3	$ 2.00	5	$3.33
Machine No. 2	6	4.00	2	1.33
Machine No. 3	8	5.33	0	.00
	17	$11.33	7	$4.66

Overtime and Shift Differentials. When employees work during overtime hours or extra shifts, the premium paid may be treated as an increase in the base wage rate, or it may be accumulated as a **separate cost element.** When such premiums are considered an increase in base rate, there is no change in the method of costing time tickets except that a higher rate is used. When premiums are considered a separate cost element, time tickets are costed at the regular rate and the premium is accumulated separately. When premiums are kept separately, special care must be used to see that the total labor cost is reconciled with the weekly payroll. (See also the discussion of Premium Payments in this section for the various alternatives in handling premiums.)

TIMEKEEPING FOR INDIRECT LABOR. Timekeeping for indirect labor is considerably less detailed than for direct labor, since indirect labor cost is allocated to products through the **manufacturing overhead application.** The most important consideration in timekeeping for indirect labor is to ensure that the amounts are correctly and properly charged for control purposes. Indirect labor costs, if not watched, may increase unduly or out of proportion to volume of production. **Budgeting or standard cost procedures** should be used to measure actual indirect labor costs, and indirect labor should be classified in such a manner that comparisons are facilitated.

Minor Repairs. Departmental mechanics, machine adjusters, and tool setters, performing routine functions, receive a new ticket either each payroll period or each day. Their wages are as a rule charged to departmental standing orders, the code being indicated on the time ticket. Where a **central repair or maintenance department** furnishes repair men to other departments, the repair department timekeeper must issue a new ticket for each job, showing specifically the department and standing order code to be charged. In both cases, repairs are charged to the department, and production costs are then charged for the repairs through the use of overhead application rates.

Re-operation Labor. Work condemned by inspectors as not up to specifications may sometimes be reworked. In such cases time tickets made out for workers engaged in repairing these products are stamped "Repair" or "Rework" and should be of a color that distinguishes them from regular time tickets. The difference in color clearly distinguishes the labor cost of repairs and prevents the quantities from being counted twice.

Idle Time, Machine Breakdowns, and Stand-by Time. Normal costs for idle time, lost time for machine breakdowns, or stand-by time should be treated as a manufacturing cost and allocated to all production through the burden application process. Unusual costs of this type should be treated as separate costs and charged directly to profit or loss as incurred, but the amounts must be material and of an "extraordinary" nature before production costs are relieved of the amounts. Such **extraordinary losses** could occur from strikes, lockouts, fire, or

water damage that require the presence of a skeleton force, even though no production is realized.

When a job order cost system is used, the time lost should be recorded as separate time and **standing code numbers** established for this purpose. In continuous-process industries, time lost due to machine breakdowns or stand-by purposes must be separately recorded, since time tickets are not utilized in most cases. Blocker and Weltmer (Cost Accounting) state that:

An important defect justly attributed to process cost accounting is the fact that management is not informed from the accounting records of the number of hours and the cost of idle time which may exist in various processes. Since the labor cost is summarized for each process at the end of the accounting period and is divided by the total production to obtain an average unit cost, no recognition is given to the idle-time element. . . . The timekeeper or supervisor in each process should be instructed to keep a daily time report of hours and minutes of idle time for each employee. Either a separate idle-time report can be prepared, or the regular daily time reports can be arranged to show the amount of idle time in a separate column.

For a further discussion of accounting for idle time, see section on Manufacturing Overhead and Normal Capacity.

Incentive Wage Payment Plans

OBJECTIVES OF INCENTIVE WAGE PAYMENT PLANS. Incentive wage payments are offered employees as an inducement to increase production. These plans are based upon payment of wages for units produced, rather than for time spent in the plant. Both employee and employer benefit from a well-constructed incentive wage plan, the employee through **increased earnings,** and the employer through **lowered unit costs.** Matz–Curry–Frank (Cost Accounting) state this view as follows:

The primary purpose of an incentive wage is to induce the worker to produce more, and by producing more to secure a higher wage while saving in total production cost per unit. Naturally, producing more in the same period of time should result in higher pay for the worker. It may also result in lower labor cost per unit and, because of the greater number of units produced, in a lower cost per unit for fixed overhead

Heckert and Willson (Controllership) list the following desirable characteristics of an incentive wage plan:

1. A wage incentive system should be based upon standards of performance—time and motion studies, job evaluations, and merit ratings.
2. The incentive plan should be understood by all employees before installation or before hiring new employees.
3. All direct labor tasks should be on an incentive basis.
4. Only standard or acceptable quality production should be considered in determining the bonus.
5. When the standard is once set, it should not be changed unless the method changes.
6. The incentive program must be fairly and intelligently administered.
7. It is highly desirable that indirect personnel share in the incentive plan.
8. A high reward should be paid for performance above standard.
9. Individual incentives should be used wherever it is possible to do so.

According to Blocker and Weltmer (Cost Accounting) the following objectives should be considered in the **selection of a wage system:**

1. Acceptance by employers to avert slowdowns and work stoppages.
2. Provision for flexibility.

3. Provision for economy in administration.
4. Supplying of labor statistics for use in industrial relations and for trade associations, governmental agencies, and competitors
5. Stabilization of labor turnover.
6. Minimizing of absenteeism.
7. Provision for incentive plans

All incentive wage plans are variations of the **straight piece-rate plan,** which pays the employee for output measured by the number of acceptable completed units. Most incentive wage plans offer the employee a **guaranteed minimum** hourly earning rate, because of the minimum wage and hour laws, even if his production does not warrant it.

From an accounting standpoint, incentive wage plans should be so constructed that they result in a reduction of the fixed overhead cost per unit by increasing the quantity of production in a given period of time. In addition to lower fixed unit costs, most plans are devised so that there is a reduction in the unit cost of labor. This reduction is accomplished by the use of a **graduated incentive rate.**

Keller (Management Accounting for Profit Control) observes: "The trend . . . is toward the adoption and use of incentive plans . . . notwithstanding the fact that they are costly to install and maintain and they complicate and increase the cost of computation of earnings."

A number of the better-known incentive wage plans are described subsequently. It should be recognized that there are many variations of these basic plans currently in use. The Production Handbook (Carson, ed.) states that no one incentive formula is appropriate for all types of work or conditions and adds: "Relatively few companies have such a limited range of working conditions that a single wage plan would be suitable for all operations. The wise selection of appropriate wage plans often is sacrificed on the false assumption that the use of more than one plan unnecessarily would complicate payroll calculations." Bennett (Standard Costs) emphasizes the idea of keeping the incentive program simple so that the workers can understand it and calculate their earnings themselves.

DIFFERENTIAL PIECE-RATE SYSTEMS. The differential piece-rate system, frequently called the **Taylor system,** is based upon two or more fixed piece rates. One piece rate is used for workers whose production is lower than the minimum amount, and a higher rate is paid per piece to workers who produce above that level.

Thus, for example, if the worker's output for the day is less than 100 units, he will receive 8 cents per unit for all production; when his production is from 100 to 120 units he receives 9 cents per unit for all production; and if his total output exceeds 120 units, he receives 10 cents per unit for all production during the day. As production increases, this system results in a higher labor cost per unit and therefore should be utilized only when savings in total cost to produce are realized by spreading fixed overhead over a larger number of units. The accompanying table, using the preceding rates and assuming a fixed cost per worker of $7.00 per day, illustrates the effect of the differential piece-rate system upon labor costs and total costs per unit.

Daily Production	Piece Rate (cents)	Total Labor Cost	Fixed Cost	Total Cost	Total Unit Cost (cents)
90	8	$ 7.20	$ 7.00	$14.20	.1578
115	9	10.35	7.00	17.35	.1509
140	10	14.00	7.00	21.00	.1500

The differential piece-rate system has the dual advantage of giving an unusually strong incentive to ambitious workers and necessitating little additional clerical effort in computing employee pay. If the piece rates are carefully set, so that increased labor costs are offset by decreases in per unit fixed costs, the system will benefit both employee and employer. The basic objective of this incentive method is to weed out inefficient workers, who soon become discouraged and leave the company. Thus a more efficient labor force is built up by a somewhat automatic process of selection.

PREMIUM WAGE SYSTEM. The premium wage system, sometimes called the **Halsey system,** guarantees the worker a minimum wage per hour but pays a premium for production in excess of the stipulated amount. Although the minimum wage is usually stated as an hourly rate, production is sometimes measured in terms of a longer period, such as a day or a week. The premium is usually based upon the time saved by producing more than the standard amount. Thus, if standard production is eight units for an eight-hour day, a worker who produces ten units will have saved two hours and will receive a premium of some percentage of the time saved. If the premium is 50% of time saved, he will receive a premium of 50% of two hours, or one hour's pay.

The premium system is easy to install, since it does not require extensive time studies. The standard hours to produce each unit may be computed on a strictly **historical basis** if necessary, for the premium is paid only if production exceeds some predetermined amount. When the premium is anything lower than 100% of the time saved, labor costs will in every case decrease per unit as production increases. This system has these added advantages: it is readily understood by the employees; their increased production will result in increased earnings to them; and the company will benefit by lowered unit labor costs. This system fits especially well those companies with relatively low fixed costs, since savings to the company do not depend upon reduced fixed costs per unit.

POINT SYSTEMS. The point system, with variations called the **Bedaux, Kim, Mannit,** and **Stevens** systems, is based upon a guaranteed minimum hourly wage, with a premium paid for units produced in excess of the standard number per hour or per day. This system differs from the premium system previously discussed, in that the units are stated in terms of points. If standard production of a particular product is 30 units per hour, each unit would be 2 points, derived by dividing the standard production into 60 minutes, or an hour's time. These points are frequently referred to as B's or M's, or some other defined term. The worker receives the guaranteed wage when his production does not exceed the standard number of points per hour; but when his production goes above this level, he receives a bonus based upon the number of points he produces above standard.

Stating production in terms of points somewhat simplifies the payroll procedure, for each worker's production can be easily reduced to terms of points earned, and these points may then be multiplied by the rate of pay. Frequently the foremen and supervisors are also granted a bonus if their department or section earns points above the standard. Since the points (or B's or M's) are uniform for each worker, the production of the whole department may be readily determined for **supervisory bonus** computations. Sometimes the **indirect workers,** such as materials handlers, timekeepers, and expediters, are brought into the plan. Their bonuses are usually based upon the points earned by the entire department or section.

STANDARD TIME SYSTEMS. The standard time system, sometimes called the **Gantt system,** allots a standard time to each unit of production and pays the worker for the standard time attached to the production which he completes. A guaranteed minimum is usually granted, and if the standard time produced is less than the guarantee, the worker is given the minimum. This type of wage system is especially adaptable to companies which use a **standard cost system,** for the standard labor time per unit must be calculated for standard cost system purposes and may easily be used without change for incentive pay purposes. McNitt (NAA Bulletin, vol. 36) states that the standard time system is different from a straight piece-rate system and contains several **advantages** that a piece-rate system does not have:

> The advantage of a standard hour rate as compared to a [straight] piece work rate lies in the fact that the standard hour provides the incentive of piece work, yet permits management to set a different hourly rate for different employees, even though they are doing the same type of work. There are valid reasons for individual rate variations to take account of considerations other than productivity.

The standard time set for each unit of production must be based upon careful **time studies,** for if the time is set too loosely, the workers will be at an advantage; and time set too tightly will discourage increased production. (See section on Setting Standard Costs.) Careful review of the established standard time must be made periodically.

Standard times may also be set for indirect or **nonproduction workers** in certain cases. While it is more difficult to measure this type of labor by standard time, indirect workers are given incentive for increased efficiency if the nature of their tasks may be measured in this way. Cropsey (NAA Bulletin, vol. 36) states that work measurement of indirect labor by **standard time data** is regarded as superior to other methods.

GRADUATED BONUS SYSTEM. The graduated bonus system, variations of which are known as the **Emerson, Wennerlund,** and **Rowan systems,** is based upon a bonus which is gradually increased as employee production increases. A base pay, or guaranteed minimum, is set, as well as a **standard production** per hour or day. As the worker approaches the standard production, he receives a bonus, which is stated as a percentage of the base pay. The standard is set so that an experienced worker, working at normal efficiency, will achieve standard production. As a worker approaches this standard, he receives a small bonus; and as he reaches or exceeds the standard, he receives gradually increasing bonus percentages. Thus, if standard production is 100 units, a worker who produces 80 units may receive a 5% bonus; one who produces 90 units may receive a 10% bonus; one who reaches standard may receive a 20% bonus; one who produces 110 units may receive a 30% bonus, etc. The following table illustrates how this bonus system may graduate up to and beyond a standard production rate of 100 units per hour, assuming a base rate of $2.00 per hour.

Production (Units)	Bonus Percentage of Base Pay	Hourly Earnings
70–79	–0–	$2.00
80–89	5	2.10
90–99	10	2.20
100–109	20	2.40
110–119	30	2.60
120–up	40	2.80

MEASURED-DAY WORK. This system is a combination of straight time wages and incentive pay. It is based upon a straight hourly rate for each hour of work but allows **automatic increases** to employees who produce more than the standard amount over an extended period. Under this system an employee's hourly rate is based upon production, but the time period used in determining the rate must be long enough to indicate that the employee is a consistently high producer, rather than one who works at high speed for one hour or day and then lags the next. Matz–Curry–Frank (Cost Accounting) describe one plan of measured-day work as follows:

One method sets time standards for jobs and requires a record of the quantity of work turned out. In this plan workers are paid an hourly base rate as a starting point. The total standard hours of work done in a pay period is compared to the actual hours worked. If a worker exceeds a stated minimum ratio for a fixed period, perhaps three months, he receives a wage increase, commonly 10 cents per hour. The ratio of standard hours of work done to hours worked is computed each pay period for each worker. There may be three or four grades of workers in a job classification, such as A, B, and C. The A worker is one who over a period of two years or some designated period of time earned this classification and higher pay by consistently producing the standard quantity or above in the standard time.

GROUP BONUS SYSTEM. An incentive method that is applicable to a **group of related workers** is used in some companies. When the workers act as a team, or when a conveyor belt or assembly line method of production is used, the group bonus is especially applicable. Neuner (Cost Accounting) describes three **advantages** of this method: (1) It develops co-operation among the group of workers, particularly when the work of one could delay production in some subsequent operation, (2) it reduces the amount of clerical work involved in computing bonuses, i.e., a bonus is figured for the group production rather than for each individual's production, (3) it reduces the amount of supervision necessary.

Several of the incentive methods discussed are used in computing the bonus for the group. These include **premium wage** system, **point** system, **standard time** system, or **graduated bonus** system. When the production for the group has been determined and the bonus computed, the bonus may be prorated to the individuals in the group, based upon (1) a ratio of individual base pay rates, (2) the basis of a ratio of each individual's base earnings as a percentage of the group's total base earnings, or (3) it may be equally distributed to all employees.

Use of a ratio of the individual worker's **base pay rates** results in a larger bonus to a worker who has a higher hourly rate, even though he does the same type of work as another employee who earns a lower rate of base pay. Since a group bonus is actually earned by the group rather than by a single individual, prorating the bonus on the basis of base pay rates is in effect a proportionate increase in each worker's base rate.

Use of a ratio based upon the **total base earnings** of each employee in the group has the same advantages and disadvantages as use of base pay rates, except that it takes into consideration the time not worked by an employee. Thus, if the bonus is determined by a week's production, a worker who is absent one day does not receive a bonus for production realized during his absence.

Dividing the bonus equally among the employees has the advantage of simplicity, but this system could be inequitable if workers do not receive approximately the same base rates. This method does, however, facilitate the bonus computation when workers are shifted from one group to another. If the bonus is divided equally among members of the group, a worker "borrowed" from another

task to fill in for an absentee would receive a pro rata share of the bonus, based upon the time he spent with the group.

Labor Distribution

PURPOSE OF LABOR DISTRIBUTION. Labor distribution accounting begins, roughly speaking, where payroll accounting leaves off. Labor distribution is strictly a **cost function**, in that it assigns payroll costs to costs of production and distribution. In Fig. 13, Van Sickle (Cost Accounting) shows the relationship between payroll and the labor distribution functions and the ultimate aim of each.

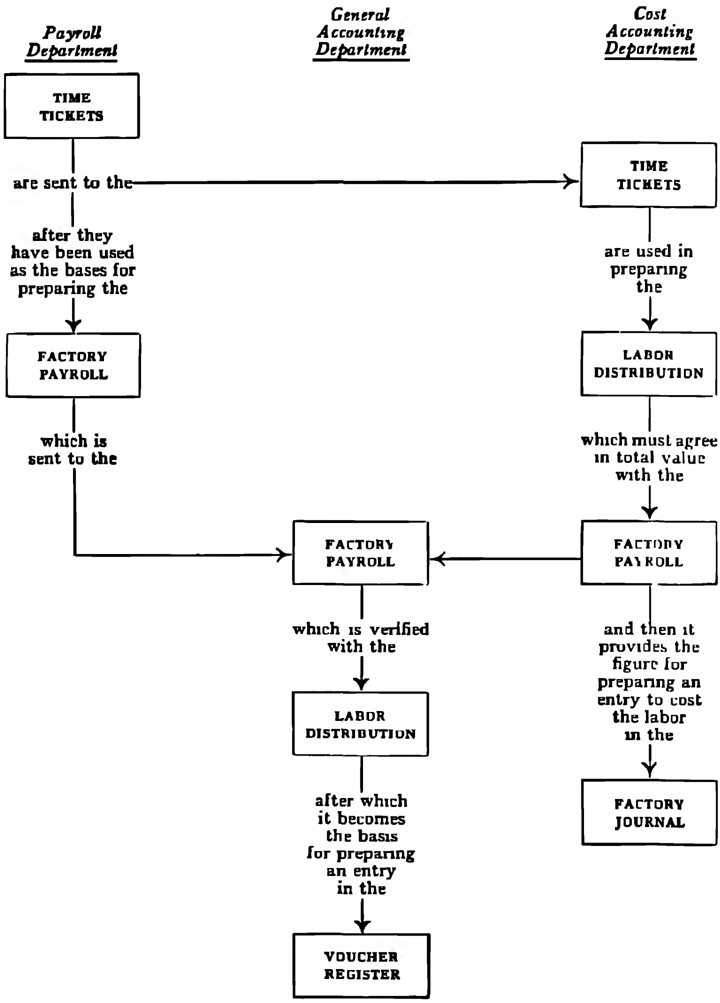


Fig. 13. Relationship between payroll department and cost department.

The final step in payroll accounting is the creation of a charge to a Payroll account and a credit to a liability account, Payroll Accrued, which is liquidated on pay day. The aim of labor distribution is to break down the charge to Payroll to show its component parts and then to make the distribution entry to close out the payroll account. Information from time tickets, time sheets, and daily production records are needed as a basis for distributing the payroll cost to products, processes, or to indirect labor accounts.

MANUAL SUMMARIZATION AND POSTING OF LABOR COSTS. In many plants most of the summarizing and posting of labor costs is done manually. The following outline represents substantially the procedure advocated in a cost manual of the National Machine Tool Builders of America:

1. The daily or weekly time tickets are segregated for direct labor and indirect labor. This sorting is also done for each department or cost center. Totals are entered daily on a departmental payroll analysis. The analysis may of course be made weekly or even monthly.
2. Totals of time tickets are checked against totals on the payroll register sheets.
3. The time tickets for direct labor are further sorted by jobs, classes of products, operations, or processes; the totals for each subclassification are computed and posted to job cost sheets, processes, etc.
4. The time tickets for indirect labor are sorted by departments or cost centers, and within each cost center by standing expense orders to show the analysis of the classes of indirect labor established for the plant.
5. Postings for indirect labor are made on a weekly or monthly basis. If weekly burden reports are required, the posting is done weekly. This is preferable to monthly posting if burden costs are to be controlled promptly and adequately.
6. Totals of direct labor charged to production and of indirect labor charged to standing orders are checked against total earnings for the same period shown by the payroll register sheets.

LABOR DISTRIBUTION ON SUMMARY STRIPS. After the time tickets for direct labor and indirect labor have been accumulated for either a day or week, many companies summarize the costs before posting to individual job records or to expense accounts. A summary strip similar to Fig. 14 can be used for this purpose and may be completed either by hand or by machine posting. The summary strips for each day are placed side by side on a **peg board** to align the separate accounts for quick accumulation of totals. The total on the summary strip must agree with the payroll for the day or for the week before the detail is transferred to job records or expense accounts.

WORK SHEET FOR LABOR COST DISTRIBUTION. After they have been posted to the detail job records, the daily time reports must be summarized as a basis for preparing a journal entry, charging the job-cost control account and the indirect labor cost accounts. This summary may be done on a work sheet type of reconciliation, as shown in Fig. 15. This **labor recapitulation work sheet** may be prepared by hand or on a machine, and is essentially a summarization of labor costs by departments and by expense or cost classifications. A work sheet of this type is especially helpful in companies where labor costs are analyzed several ways, such as by departments, processes, and jobs. This type of work sheet is applicable in those situations where time tickets have already been analyzed or tabulated by groups, as is the case when unit tickets or perforated and detachable time tickets have been removed and totaled.

LABOR DISTRIBUTION ENTRIES. At the end of the week or month totals from the summary sheets are entered on **journal vouchers** or in the

DAILY LABOR SUMMARY		
	DATE________	DEPARTMENT________
DIRECT LABOR		
ORDER NO.	HOURS	COST
TOTAL DIRECT		
INDIRECT LABOR		
TOTAL INDIRECT		
GRAND TOTAL		

Fig. 14. Daily labor summary strips.

applicable journal. Fig. 16 illustrates a journal voucher for the distribution of the monthly labor cost. A simple form of entry is:

Work in Process	$	
Manufacturing Overhead Control	$	
Payroll Accrued		$
(To summarize direct and indirect payroll for January, 19___.)		

This entry may be varied by introducing departmental work-in-process accounts or subdividing work in process according to cost elements. The credit to Payroll Accrued is necessary when the cost distribution entry is prepared by one department and the payroll entry for the payroll is prepared by another. The Payroll Accrued account is a **clearing account** and is frequently entitled Payroll or Pay-

LABOR RECAPITULATION

DATE________

CODE	CLASSIFICATION	DEPARTMENT							
		MACHINING (4000)		ASSEMBLY (5000)		MAINTENANCE (6000)		GENERAL PLANT (7000)	
		Hours	Amount	Hours	Amount	Hours	Amount	Hours	Amount
	DIRECT LABOR:								
000	St. Time								
000	Piece Work								
000	Bonuses								
000	Overtime								
	INDIRECT LABOR:								
010	Maintenance								
011	Materials Handling								
012	Plant Management								
013	Production Control								
014	Timekeeping								
015	Traffic								
016	Quality Control								
017	Engineering								
018	Clean-up								
019	Idle Time								
020	Reoperation								
021	Drafting								
022	Cost Department								
023	Industrial Relations								

Fig. 15. Labor cost distribution sheet.

No. 148

JOURNAL VOUCHER

Labor Distribution, Period______ to______

Account		Amount	
Number	Title	Dr.	Cr.

Audited by__________ Approved by__________ Entered by__________

Fig. 16. Labor distribution journal voucher.

roll Clearing. Thus the entry to record the actual payment of the payroll, which is prepared by the payroll department, would be:

Payroll Accrued	$	
FICA Taxes Payable		$
Employee Income Taxes Withheld, Payable		$
Other Payroll Deductions		$
Cash		$
(To record payroll and payroll deductions, week ending 7/12/___.)		

Through these two interconnected entries, the wages earned by employees are charged to the appropriate cost accounts as earned, and the resulting payroll accrued is reduced when the wages are actually paid.

Payroll Methods

PAYROLL DEPARTMENT. The basic task assigned to the payroll department is to translate the time worked by employees, or the number of units produced by workers, into **dollars of pay** by:

1. The application of pay rates to hours of work or units of production to arrive at gross pay.
2. Subtraction of payroll deductions to arrive at net pay.
3. Preparation of the paychecks and related payroll reports and documents.

Thus the functions of the payroll department may be summarized in the following list:

1. Determine regular and overtime hours.
2. Check and enter all wage rates.
3. Compute regular and overtime pay.
4. Compute additions to base pay, including premiums and bonuses.
5. Compute payroll deductions.
6. Calculate and enter net pay.
7. Prepare all necessary documents in connection with the payroll, including payroll registers, paychecks, and payroll tax returns.
8. Prove all subsidiary records against control totals, including the employees' individual earnings records.
9. Supply management and employees with payroll data and reports as needed.
10. Deliver prepared checks and necessary accounting data to the proper persons.

The responsibility for disbursement of the resulting pay checks or pay envelopes is charged to the **paymaster**. For control purposes, the paymaster should not be assigned to the payroll department and preferably should be a part of the **treasurer's staff**. After the payroll has been prepared by the payroll department, the paymaster should review it both in detail and in total, sign the checks, or fill the pay envelopes if payment is made in cash, and distribute the pay to employees. The **payroll sheets** or **journals** are then passed to the general accounting department in summary form for entry into the books of account.

PAYROLL DOCUMENTS AND RECORDS. Standardization of the documents and records kept by payroll departments is impossible, since local conditions and needs for payroll data vary. Certain basic documents, forms, and reports, however, are common to almost all payroll systems. These include clock cards or attendance registers, payroll journals, pay checks or pay envelopes with attached pay stubs or employees' earnings statements, individual employee's earn-

ings records, and **employee service records.** These basic documents take many different forms and may be prepared in many different ways, but the purpose and content of these records is basically consistent.

Clock Cards and Attendance Registers. The clock card consists of an individual time card for each employee, upon which the time checked "in" and "out" are stamped for each working period by a clock-driven printing mechanism, or **time clock.** Usually the clock card provides spaces for an entire week, with separate spaces for morning, afternoon, and night shifts. The difference between the "in" and "out" times indicates that period in which the employee was in the plant. Each day's **recorded in-out time** as shown on the clock card should be checked against the total **elapsed time** on the worker's individual job tickets for assurance that an employee is paid only for time actually worked. Each employee's clock card should be approved by the foreman or superintendent before it is sent to the payroll department.

Attendance registers are sometimes used instead of clock cards. These records are usually prepared by foremen, timekeepers, or supervisors, and they contain basically the same information as the clock card. Attendance registers are sometimes prepared by clock or printing devices and are sometimes prepared manually.

Payroll Registers. The payroll register is also called a **payroll journal** or **payroll summary.** These documents show each employee's clock number, name, the days included in the day period, the hours worked on each of those days, the number of straight-time hours worked and the number of overtime hours, the employee's rate of pay, the total or gross earnings, the various deductions from gross pay, and the net pay owed each employee. If payment is to be made in cash, spaces are sometimes provided on the payroll register for the employee's signature when he receives his pay. When payment is by check, the check numbers of the individual checks are shown on the payroll register. These registers may be prepared manually or on accounting machines. Usually the payroll register contains the original computation of the employees' earnings.

Pay Checks or Pay Envelopes. Pay checks are prepared on prenumbered stationery, which should be carefully safeguarded. Spoiled, voided, or blank checks should not be discarded prior to audit. Spoiled or voided checks should be mutilated by tearing the signature space from the check, thereby preventing their re-use. Pay checks are provided with stubs, either at one end or along the top or bottom margin. The elements from which net pay is derived are listed in detail on the stubs.

Pay envelopes should be prepared and the employee's name and pay information entered prior to filling the envelopes. The face of the envelope should provide space for entering all elements used in computing net pay, including production figures if a piece-work rate is used, and all deductions. Frequently the flap of the envelope is designed to be detached, signed by the employee upon receipt of his pay, and retained by the paymaster as acknowledgment of receipt.

Individual Earnings Records. The Fair Labor Standards Act of 1938 requires that employers maintain individual records for each employee, showing name, occupation, basis for paying wages, additions to and deductions from wages, length of time covered by the pay period, and any overtime premiums paid. This information is usually posted to the individual earnings records after the payroll has been prepared, although it may be done simultaneously by use of **accounting machines.**

The employees' individual earnings records are the basis for preparing annual reports to employees, such as **W-2 forms** for federal income tax purposes. These forms contain data concerning total wages earned during the year, and federal income tax and FICA withholdings. Since both state and federal **unemployment compensation taxes** assessed against an employer cease as each employee reaches a fixed amount of earnings for the calendar year, the individual earnings records of each employee must provide figures showing earnings on a cumulative basis, beginning January 1 of each year.

Employee Service Records. In most companies it is desirable to maintain a permanent record of the **service history** of each employee. These records contain data concerning the employee's past experience, previous education, educational courses taken while employed, awards or emblems received, ratings by supervisors at specified periods, positions and corresponding salaries while with the company, accidents, leaves of absence, etc. The employee's service record should be fully supported by appropriate documents. These documents include change-of-pay slips, notices of job changes, W-2 forms for earnings and withholdings, authorizations signed by the employee for payroll deductions, and physical examination forms. When the employee leaves the company, this record should state fully the reasons for his termination.

CHANGES IN PAYROLL STATUS. The two basic documents authorizing new persons to be placed on the payroll or new rates of pay for current employees are:

1. The **employment report.**
2. The **payroll change report.**

These two documents present an orderly method for obtaining written approval by the payroll department. Also, forwarding copies directly to the personnel department and other interested divisions will usually provide a sounder system of **internal control** over payroll changes. The payroll change report should originate with a supervisory employee who has authorization to hire and discharge, to initiate transfers, or to grant salary adjustments and increases. Minor supervisory personnel should not be allowed to prepare or authorize payroll change reports.

The following **changes in payroll status** are easily handled through the payroll change report:

1. Removals from the working force.
2. Transfers from one payroll unit, office, or department to another.
3. Changes in rate of pay.
4. Leaves of absence granted.
5. Changes in titles or occupational code.
6. Changes in classification, such as from temporary to regular, part time to full time.
7. Changes in name, such as may result from marriage.
8. Delayed assignment of Social Security numbers.

TOOL ISSUANCE RECORDS. The tool issuance record (Fig. 17) constitutes a record of tools, keys, badges, identification cards, safety clothing, etc., issued to each employee. It may be a separate form, or it may be printed on the reverse side of a copy of the **employment report.** The payroll and plant tool departments maintain controls through this form to ensure that all items issued to an employee are returned upon termination of employment. The tool issuance

record, properly signed, should be required by the payroll department before final wages are paid. The tool issuance record may thus be used as an **employee release card.**

In some plants an employee must have both a signed tool issuance card and an **order for final wage payment** before receiving his final pay. Separate orders for final pay are used when the employee must clear through several departments, such as the health department, the personnel department, and the payroll department.

EMPLOYEE'S NAME .... DEPT. ....

LOCKER KEY NO. | IDENTIFICATION BADGE NO.

DATE ISSUED	DATE RET'D	SIZE	DESCRIPTION OF TOOL	REQ'N NUMBER	REMARKS
Empl. Mgr	Dept Fore	Supt.	Head T K		

ALL OF THE FOREGOING HAVE BEEN RETURNED IN GOOD ORDER EXCEPT AS NOTED UNDER "REMARKS."

SIGNED: ____________________
STOREKEEPER.

Fig. 17. Tool issuance record form.

PAYROLL SYSTEMS. The payroll system comprises all the procedures of gathering the necessary payroll information, processing this information and computing earnings, preparing the pay checks, and disbursing the pay. Each system must be tailored to the individual company, and constant care should be taken to assure that clerical costs in the payroll department are held to a minimum. Neuner and Neuner (Accounting Systems) state: "Payroll accounting is next in importance to cash and inventory because of the possibility of fraud. The vast amount of clerical work involved today in payroll accounting makes a good payroll accounting system a prerequisite for successful business operations."

Manual Payroll Systems. Smaller companies with only a few employees sometimes use a manual system of preparing and recording the payroll. This system usually consists of manually computing earnings from time cards or attendance registers, preparing checks by hand, and hand-posting data from the payroll register to the individual earnings records. A manual system is rarely the most efficient method of handling a payroll, even when there are only a few employees. **Mechanical devices** such as pegboards or combination adding-machine–typewriters can combine many of the repetitive tasks of the payroll function.

Pegboard Payroll Systems. In order to eliminate the rewriting required in a manual payroll system, **collated procedures** made possible through use of payroll boards have been devised. These boards are usually a type of pegboard which holds the **payroll journal, pay check** or pay envelope, and **individual earnings records** in alignment. Thus the documents may be prepared simultaneously through the use of carbon paper. The following advantages are claimed for these boards:

1 **Accuracy.** Since original figures are duplicated through carbons, all three records are in agreement. This eliminates errors in copying from one form to another.
2. **Economy.** No special or elaborate equipment is necessary beyond the pegboard and a calculating machine. Clerical cost is reduced to a minimum.
3. **Speed.** A clerk can easily assemble the three or four necessary forms in two minutes or less. The forms may be assembled in advance on extra demountable peg strips in readiness for payroll closing. The time required to post the payroll depends upon the character of the original payroll data and the number of deductions to be made. There is only one writing and one computation, and there is only one set of totals to balance; hence operations are reduced to a minimum.
4. **Flexibility.** The work may be distributed among any desired number of clerks, who can work simultaneously on the production of the payroll. Form design is flexible. Additional classifications can be accommodated without being limited by machine capacity.

Mechanical Payroll Systems. Extensive use of mechanical equipment is usually advantageous in large companies because of the repetitive nature of the payroll function. Machines are available which will multiply as well as print, so that the operator need only enter the hours worked and the employee's pay rate into the machine, along with deduction data. The machine will complete the payroll journal, the pay check or pay envelope, the individual earnings record, and any other payroll forms that contain these data. The machine does this in one continuous operation. (See description in this section under Machine Methods in Labor Costing.) Modern payroll machines also accumulate totals by departments or other groupings for proof purposes and for entering payroll entries into the books of account. One machine that simultaneously computes and prints the payroll data also prepares a payroll journal, pay check, and individual earnings record. For a description of processing a weekly payroll by electronics, see section on Basic Cost Records.

Machine Methods in Labor Costing

AREAS WHERE MACHINE SHORT CUTS ARE AVAILABLE. The possibilities of labor and time-saving devices are practically unlimited. Modern machines can be devised to perform almost any task of a repetitive nature and prepare almost any number of documents that management may desire. Short cuts are most frequently found in timekeeping, costing of elapsed time, and labor distribution processes. Short cuts may be accomplished by eliminating some documents, preparing several documents simultaneously, or preprinting parts of documents in advance in large quantities.

The following functions are especially subject to **modern machine methods** in labor accounting:

1. **Classifying.** Classifying and reclassifying the many types of labor costs by jobs, processes, departments, costing centers, operations, and groups of per-

sonnel may be facilitated by the use of machines. Manual methods of sorting are slow, tedious processes, and modern machinery permits the rapid classification necessary for timely and accurate reports.

2. **Calculating.** Addition, subtraction, multiplication, and division can be performed rapidly and accurately by machinery. Payrolls and labor distribution require a large amount of detailed calculation, including computation of employees' wages, costing elapsed time, and totaling job or departmental costs. Modern machines not only do the calculating but also automatically prove themselves by subtotaling and cross-totaling at any designated point.
3. **Summarizing.** Modern accounting machines are equipped to total at any designated point and will add or subtract from this total any desired data put into the machine. They are usually flexible enough to be adapted to produce any accounting or analytical document required.
4. **Printing.** Either listings of individual items put into the machine or totals of many items may be printed by use of modern accounting machines. Several documents or reports may be printed simultaneously, saving valuable time and reducing the possibility of errors.

While the original outlay for these machines frequently is large, savings in clerical labor will offset the **original investment**, if selection is proper. Mechanical methods ranging from Keysort techniques to electronic data processing are adaptable to the repetitive nature of payroll and labor distribution functions.

PREPARATION OF RELATED DOCUMENTS IN A SINGLE OPERATION. This is perhaps the area in which the greatest savings in effort may be realized by the use of accounting machines for payrolls and labor distribution. In the preparation of the payroll, the employee's individual earnings record, the payroll check, the payroll register, and the employee's statement of withholdings may be prepared in one **continuous calculating and printing process,** requiring only a few seconds' time for each employee. In labor costing and distribution, the labor cost sheets, individual job cards, and labor cost and efficiency reports may be prepared simultaneously.

The following procedures, taken from the payroll manual of a company with 6,000 employees who are paid at the end of each week, illustrate the high degree of efficiency that is possible by use of machines:

> The payroll machine operator inserts five addressed copies of the payroll sheet around the platen of the machine, each sheet containing space for 40 names. The corresponding 40 checks are placed in the magazine. Time cards and earning records sheets are placed on the left-hand check table. The necessary data are entered on the keyboard. The machine computes the earnings, deductions, and net pay, and writes the following records in one operation:
>
> 1. Earnings statement for each employee.
> 2. Payroll check for each employee.
> 3. Individual earnings record for each employee.
> 4. Five copies of the payroll sheet.
>
> After the payroll records for the last employee in each group of 40 have been written, the payroll machine operator totals the ten accumulating registers of the machine, printing the totals at the bottom of the payroll sheet. These totals are the accumulations of old earnings to date, new earnings to date, premium hours, total hours worked, gross pay, five different deductions, and net pay. As soon as these totals are printed, the payroll machine operator gives all media and completed records to the proving and control clerk.

The use of punched cards as **time tickets** (Fig. 21) further facilitates the employment of machine methods to accumulate labor costs and distribute labor to

jobs, orders, and departments. Once the **labor card** has been punched with the data for time, rate, labor cost, and department, machines are used to provide as many breakdowns of the labor cost as management may need and automatically prepare reports either in detail or in summary.

ELIMINATION OF TIME TICKETS. Labor costing may be modified through the complete abolition of time tickets. The labor-costing system may be built around the use of **Telautograph** combination sending and receiving machines installed in the shop. A similar set of machines with auxiliary receivers is installed in the office. Instead of using time tickets, each machine operator writes the original labor record on the shop transmitter, which simultaneously reproduces the same record on the receiver in the office. An operator there posts the information as received to both the individual employee's payroll record and to job cost sheets.

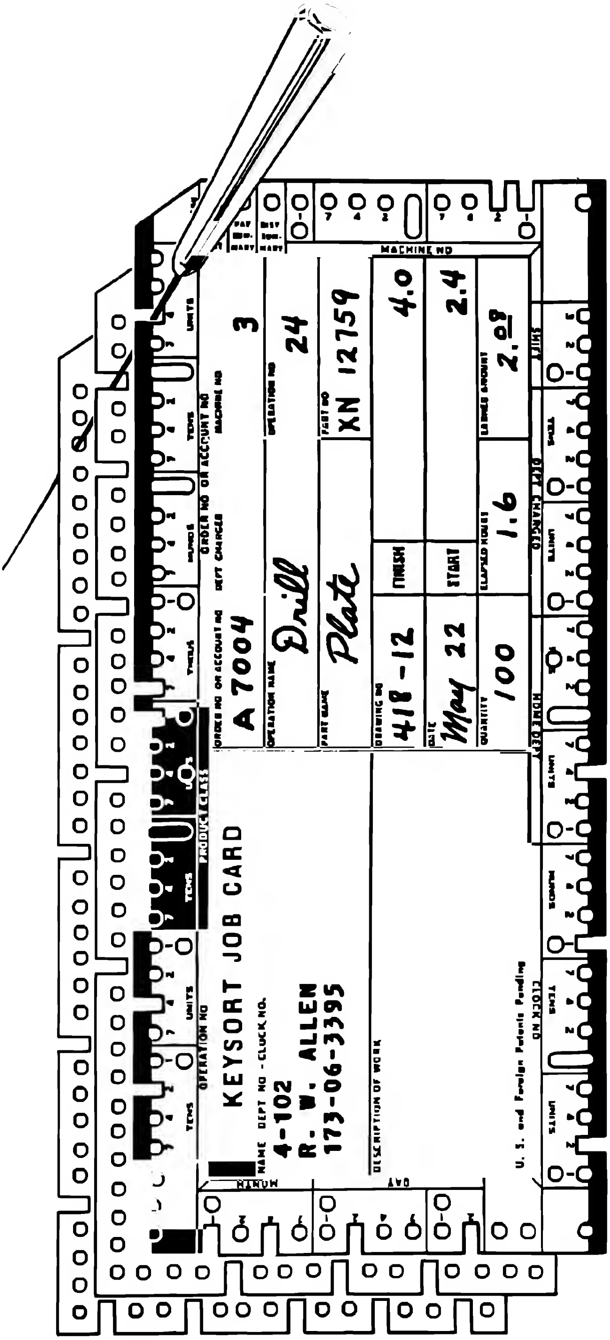
KEYSORT METHODS. The Keysort technique is an economical, easily administered, and efficient **method of sorting.** The Keysort card (Fig. 18) has holes punched around its four sides and may be coded with numerical, alphabetical, or other classifications that fit the needs of a particular company. Frequently keysort cards are used as time tickets. After data have been entered on the card by the timekeeper or worker, the appropriate holes are notched or punched for sorting. Punching may be accomplished in any one of three ways:

1. **Hand Punching.** A small punch, similar to a conductor's hand punch, is used to cut **notches** in the cards, one at a time. This method is used when the volume of cards to be punched is small, when speed in punching is not an important factor, or when it is not convenient to use a mechanical punch.
2. **Key Punching.** The key punch is a machine which looks and operates very much like an adding machine It punches an entire side of one card while the card remains in one position. It is used for **high speed punching** when the codes to be punched vary from one card to another.
3. **Gang Punching.** When several cards are to be punched with a **common code,** such as department, job order number, or date, a gang punch is used. This device, which usually operates by foot power, will punch up to several hundred cards at one time.

The cards are sorted by use of a **steel needle,** similar to an old-fashioned ice pick. It is possible to handle several hundred cards at one time with the sorter The needle is inserted into the hole for a particular classification, and if the hole has been notched, the sorter will not pick up the card. Thus cards may be sorted quickly by departments, subsorted by direct and indirect labor classifications, and further subsorted by pay-rate groups. Further sorting may be done by job numbers, processes, or cost centers.

After they have been sorted, the cards are ready to be totaled. When totals for each grouping have been determined, the amounts are frequently placed on **summary cards** of the same size and shape as the individual Keysort cards. These summary cards usually provide spaces for writing dollar totals and may be placed as separators between groups of cards after sorting and totaling. Mohney (New York Certified Public Accountant, vol. 17) describes the following **summary card advantages:**

1. They provide a convenient depository or ledger record for posting totals.
2. They speed adding, in that they serve as a stop card between groups of cards.
3. They automatically prove posting to the right account.
4. They provide a unit record of totals, which may be keysorted to obtain further summarizations.



Royal McBee Corp.

Fig. 18. Keysort time ticket.

The use of Keysort cards as time tickets and the resultant saving of time is illustrated by Lemke (American Business, vol. 20):

While this system localizes information for purposes such as setting up budget controls, it also localizes and spots errors. . . . Balancing time tickets with the payroll daily instead of weekly has eliminated peak work loads. The system is flexible enough so employees can handle other jobs without experience or previous training. . . .

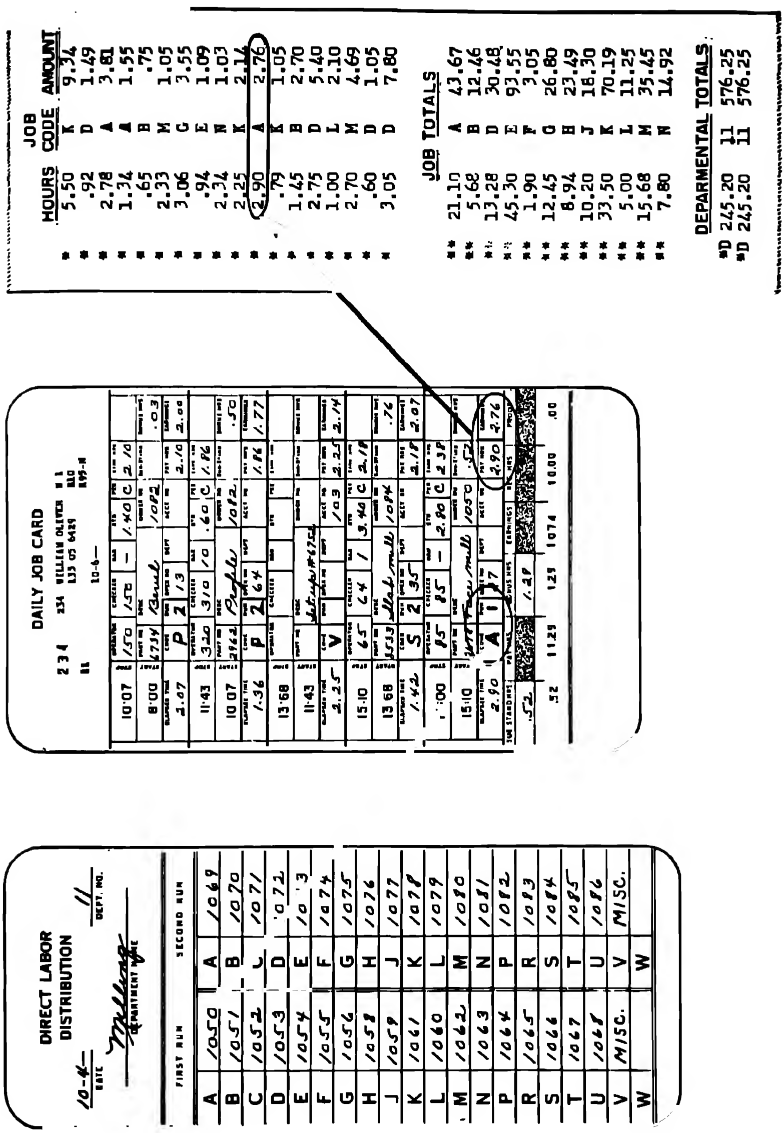
First time cards are addressographed with the employee's name, clock number, and Social Security number. When these cards are delivered to the cost department, the employee's clock and department number are prepunched for quick sorting and identification. Time tickets are then delivered to factory department files, where employees fill in a time card for each job. Time clerks in the factory departments complete the information on the time cards and send them along to the payroll department each day. . . .

Production and actual hours are also posted on Keysort summary cards after totaling. By the middle of the afternoon efficiency reports covering the previous day's work are distributed to department heads and key personnel. . . . Time cards are then gang punched to show date and shift. . . . Cards are then sorted by direct and indirect labor charged according to commodities produced. Departments are charged with these [labor costs] by postings on departmental sheets. Totals on these departmental sheets are balanced with the totals on labor distribution cards, which contain figures on both direct and indirect labor. These Keysort labor distribution cards are used to prepare monthly operating statements for principal departments. They indicate how well a particular department is doing as compared with previous records and standards set for the department. These reports include direct and indirect labor expense and will show percentage of budget realization.

DISTRIBUTING LABOR COSTS WITH ACCOUNTING MACHINES. Distribution by accounting machines of detailed labor costs to jobs results in reduction of clerical costs and rapid preparation of labor cost reports. One of the most efficient means of distributing labor costs is through use of an accounting machine that utilizes **multiple accumulating registers.** These multiple registers permit many totals to be accumulated at the same time.

One method of multiple accumulation of labor costs is illustrated in Fig. 19. The first step in this machine technique of labor cost distribution is to assign code letters to all jobs in process. A direct labor distribution **code listing** is prepared, and alphabetical codes are assigned to each job order worked on during the day, or each job to which labor is to be distributed. Since the accounting machine can accumulate only 20 totals at one time, several runs on the machine may be necessary if distribution is to be made to more than 20 jobs. Only 20 **code numbers** are needed, one for each accumulating register of the machine, and the jobs must be coded as "first run," "second run," etc.

After all job numbers have been coded and the number of runs determined, the code and run numbers are entered on each part of the time ticket involving a labor cost. The operator of the machine is then ready to enter the data on the machine. The operator scans each **daily job card** (Fig. 19) for items to be picked up on the first run and enters on the keyboard the labor hours, the job code, and the labor cost. The machine prints a tape (Fig. 19) showing the individual items of data entered in the machine. When all tickets having labor costs to be distributed on the first run have been entered, the operator depresses the totaling keys, and the machine prints job totals from the individual accumulating registers for the 20 jobs in the first run. Then the cards are processed again for the second run, and totals are printed for all jobs included in that run. This process is repeated until all costs have been distributed. After all jobs have been processed,



National Cash Register

Fig. 19. Distribution of labor costs on multiple-register machines.

departmental totals may be accumulated, as well as totals for all labor costs for the day.

One of the principal **advantages** of multiple register accumulation and distribution of labor costs is that the machine operator may pick costs at random from the time tickets, and the machine will automatically distribute them to the correct job. The job orders do not have to be sorted in any particular order, and the operator can work at high speed, processing hundreds of cards in a short time. The machine reduces the possibility of clerical errors in totaling labor costs and facilitates a proof between daily labor distribution totals and payroll totals.

POSTING TIME TICKETS BY MACHINE. Most companies post labor data in a **vertical process**, which is essentially a columnar accumulation with totals at the bottom of each column. Frequently **cumulative totals** are also printed in columnar form as each individual item is entered. When this method is applied to job tickets, the result is a columnar listing of job costs, with cumulative totals showing the labor cost on each job to date.

One method of utilizing machines to post time tickets is diagramed in Fig. 20. In this particular system only two steps are required to complete the labor costing and distribution process from the time the job tickets are first prepared in

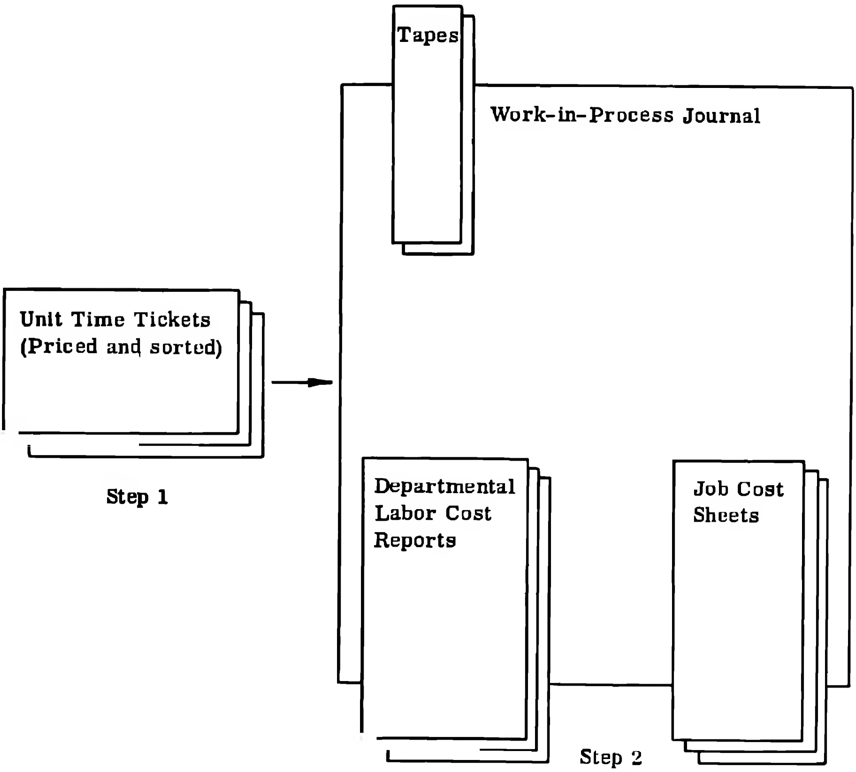


Fig. 20. Two-step process for posting time tickets by machine and preparation of reports.

the plant until all labor records and reports have been completed. The two steps of the process are described as follows:

1. **Preparation of time tickets.** This method is best adapted to the use of unit tickets, or daily tickets that have detachable sections for each job worked on, since the time tickets must be sorted by job numbers before posting may be undertaken. Costing and sorting of the time tickets may be done manually or by use of simple calculators or rate tables.
2. **Posting the time tickets.** After they have been priced and sorted, the time tickets are ready for posting. The machine operator places the following forms in the machine:
   a. The work-in-process journal.
   b. The departmental labor cost report.
   c. The appropriate job cost sheets.

Since the time tickets have been sorted by job number within each department, the **machine operator** begins with the stack of unit tickets and proceeds to accumulate and print job costs until all tickets for the department have been processed. This process is continued until all tickets for all jobs in all departments have been entered into the posting machine and are recorded in the journal, in the daily efficiency report, and on the appropriate cost sheets.

The detail of each job ticket is not posted. If this were done, the large number of tickets would make the journals and reports bulky and unwieldy. The machine has accumulating registers, and when data from time tickets are entered into the machine for a particular job, no figures are printed until all tickets for that job have been entered. When one job cost total has been accumulated and printed, the machine is automatically cleared to begin accumulating hours and costs for the next job. Since several accumulating registers are in the machine, it will accumulate both hours and costs for each job and will retain these totals for accumulating departmental and daily grand totals.

As it prints the labor cost data on the reports and cost sheets, the machine also prints a tape showing the detail of the hours and labor costs on the individual job tickets. This tape thus contains a **sequential listing** of the tickets as entered, and in case of error it may be used to locate quickly the ticket that has been incorrectly entered into the machine. The total on the tape is the labor cost for the day, and it may be used to reconcile the labor distribution totals with the payroll totals. Such documents as the work-in-process journal and ledger, and departmental direct labor reports can be prepared by the machine after it has accumulated and printed data directly from the job tickets.

PUNCHED-CARD TIME TICKETS. Punched cards are especially adaptable as **job tickets** because each card can contain a large amount of data, and reports can be prepared easily by using these cards as basic media.

Time tickets prepared by use of punched cards have the following advantages:

1. One basic document, the punched card, contains all data related to time, rates, production, employee efficiency, etc.
2. Through use of printing machines, these basic data can be placed in any desired report quickly and without clerical error.
3. Cumulative and comparative labor cost reports can be prepared quickly and conveniently.
4. Data can be entered on the cards more quickly by punching the cards than by handwriting or other conventional methods.

The basic flow of data in a punched-card system of labor costing may be summarized as follows:

1. Preparation of the cards in the production and scheduling department.
2. Completion of time data in the shop by timekeepers or other employees.
3. Costing and extending the cards.
4. Printing labor cost reports from the cards.

Preparation of Punched-Card Time Tickets. Master cards are maintained **in the scheduling and planning departments** for each product regularly manufactured or kept in stock. These master cards are designed to guide a punching machine so that it automatically punches a group of cards to be used as time tickets for a job. Usually a **gang-punch** technique is used to cut time cards from the master card, although hand punching may be necessary when the operations being performed have been revised because of engineering or manufacturing changes, or when special orders are being manufactured to customers' specifications. Data transcribed to the individual cards from the master consist of the operation, the number of pieces to be manufactured, the department, the standard time (if standards are used), the order number, and the part number (Fig. 21).

After they have been punched, the cards are given to the foremen and serve both as authorizations to produce the indicated products and as preprepared time tickets for the employees. The foremen then give the cards either to the individual workers or to the timekeepers.

Completion of Time Data in Plant. Time data are usually manually entered on the card in the plant. This is done by either the individual employees or by the timekeeper. The following procedure outlines the duties of the timekeepers in one company using punched cards.

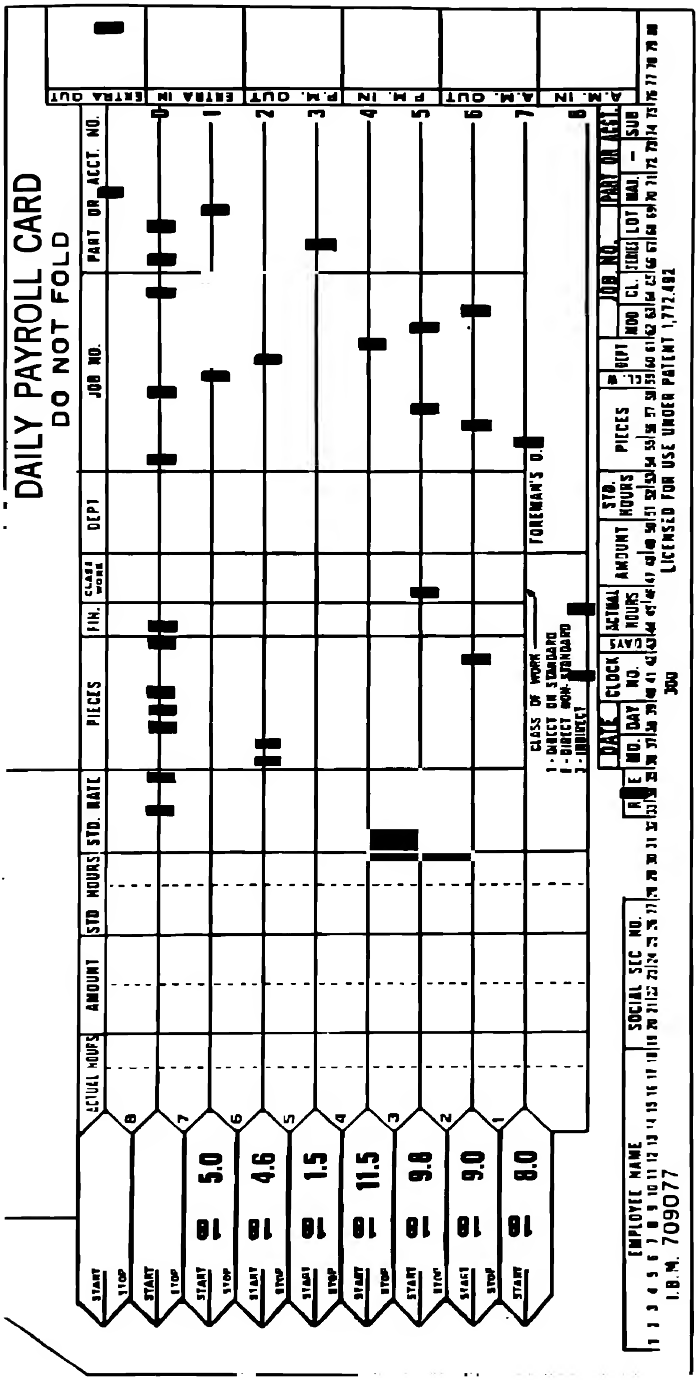
Upon receipt of the time cards from the foreman, the timekeeper files the job cards in a **jobs ahead file** until time for the job to be started. The timekeeper then removes the job card, stamps the time started by means of a **time recorder,** posts the worker's number and pay rate to the card, and files the card in a **jobs-working file.** Upon completion of the job, the operator or the foreman notifies the timekeeper and supplies the number of units produced. The timekeeper removes the card from the jobs-working file, enters the number of units completed, and stamps the time stopped by use of the time recorder. The completed cards are then forwarded to the office.

Pricing and Extending Time Tickets. Employee pay rates or piece-work rates may be entered on punched-card time tickets by **prepunching,** by using **shop pricing cards,** or **master pricing cards.** Rates may be prepunched into the card before it is sent to the shop.

When shop pricing cards are used, files of pricing cards are maintained in the shop with various rates punched into them. When a job ticket is completed, the timekeeper attaches the appropriate pricing card, and the two cards are sent together to the office. There the rate is automatically transcribed by punching from the rate card to the time ticket. The shop pricing card is then returned to the shop timekeeper for re-use.

When master pricing cards are used, the timekeeper sorts the cards by **rate groups** and forwards them to the office. There a master rate card is used to gang-punch all cards with similar rates.

Punching the labor cost into the ticket may be done manually through use of master cards or by use of an automatic multiplying punch. **Manual punching**



International Business Machines Corp

Fig. 21. Punched-card time ticket.

is done when the volume of cards is not too heavy. **Master cards** are used when the number of units produced is fairly constant and the number of pay rates is limited. This process consists of sorting the cards into groups with like units and pay rates and placing a master card before each group. The master card contains the labor costs for those cards, and this figure is automatically transcribed to all cards until the next master card is entered.

The **automatic multiplying punch** is used if the volume of cards is great and there is a wide number of different units and rates on the individual cards. This machine will automatically multiply the number of units punched into the card by the pay rate punched in, and will automatically punch the result.

Printing Labor Cost Reports from Cards. The preceding operations have resulted in cards that contain complete data concerning units of production and labor costs. Through use of **sorting** and **collating machines,** the cards may be arranged in any desired sequence for report preparation. Machines for sorting and classifying purposes may segregate hundreds of cards in 60 seconds. The final step in the punched-card system is the listing or compiling of the punched data into printed reports.

Combination adding, subtracting, and printing machines or **tabulators** are used for this purpose. Only that punched information desired for a particular report need be printed, and data may be drawn from the cards for departmental reports, job cost reports, labor efficiency reports, analysis of piece-work costs, and production reports. Fig. 22 illustrates the form and variations of reports that may be drawn from a completed job ticket.

ELECTRONIC DATA PROCESSING OF LABOR COSTS. The original data fed to the **electronic computer** must be placed on tapes or punched cards. (See section on Basic Cost Records for a discussion of the general principles of electronic data processing.) Thus the computer is primarily an extension of the punched-card method. Aiken (NAA Bulletin, vol. 38), describing the installation of an electronic system for his company's payroll and labor cost distribution, states:

> Inasmuch as our plants were already set up to produce punched cards as the first step in most of the accounting processes, we tied into the system at this point with a card-to-tape converter which transcribes 80-column tabulating cards onto magnetic tape at the rate of 240 cards per minute. The converter is composed of three units—a card-reading unit, a tape-recording unit, and a verification unit which rereads both the card and the tape and compares the two

The data resulting from electrical computations must also be taken out of the machine on tapes or punched cards. Stirling (NAA Bulletin, vol. 38) describes the installation of an electronic computer for payroll purposes in his company as follows:

> Deductions are accumulated and the net pay for each employee is computed [by the machine]. Output cards contain all pertinent data for the employee's weekly earnings and deduction records. Earnings and taxes are up-dated for the year for each employee. From these earnings and deduction output cards, the payroll registers and tabulating card checks are prepared on the tabulating printing machines. Output cards for premium earnings computed in the gross to net program are punched to complete the accounting distribution phase of the program. These distribution output cards are combined with the cost distribution cards. . . .

Fig. 23 and the following steps illustrate how punched cards may be prepared, sorted, and fed into the electronic computer, and how the electronically computed

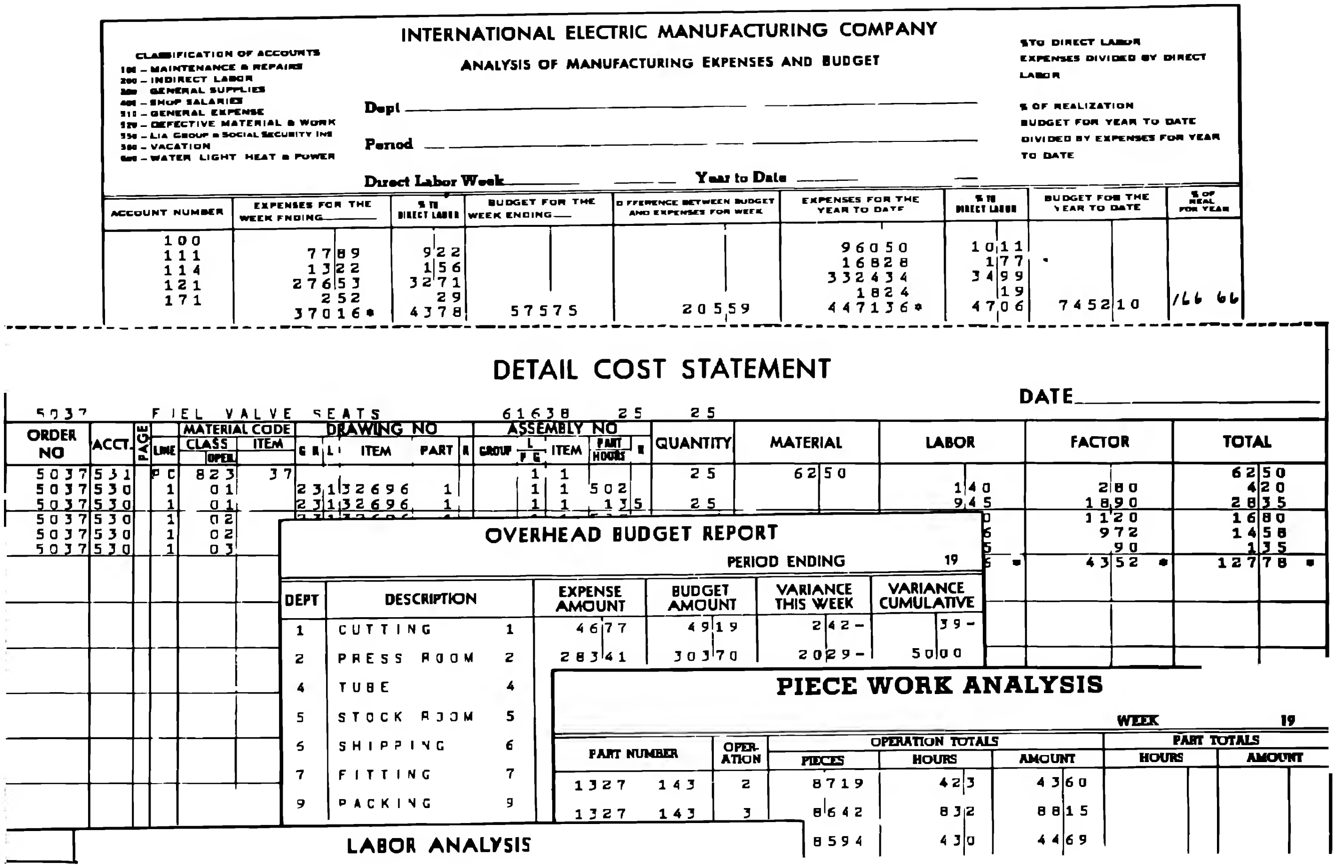
results are punched into cards. These new cards emerge in sequence and are ready to print any required **payroll and labor cost reports.**

1. Each department maintains attendance cards, prepunched with the employee's number and the department number. **Attendance hours** are punched into the appropriate cards by the timekeeper, and the cards are segregated by departments and sent to the computer center.
2. Job tickets are prepunched with department number, job code, and rate (where applicable) and are given to the timekeeper by the production scheduling department. The timekeeper punches the employee number and rate (where applicable) and the **elapsed time** on the card when the job is completed. These cards are segregated by departments and forwarded to the computer center.
3. Deduction adjustment cards are punched in the payroll or personnel departments for changes in the number of exemptions, bond purchase deductions, etc. These are segregated by departments and are sent to the computer center.
4. In the computer center the attendance cards, job tickets, deduction cards, and employee's year-to-date earnings cards (prepared when the previous payroll was computed) are fed into the computer. At the same time cards with all current job numbers and **employee master cards** are placed in the machine.
5. The computer then:
   a. Balances job cards to attendance cards by departments.
   b. Selects the greater of piece-rate, hourly rate, or guaranteed rate (where applicable).
   c. Extends hours by rate, or pieces by rate, for both regular and overtime earnings.
   d. Calculates all government tax deductions.
   e. Reduces gross pay by required and voluntary deductions and computes net pay.
   f. Develops new year-to-date earnings figures for each employee.
   g. Distributes labor costs by job number and department.
6. The computer feeds information to the **card-punching machine**, and cards are punched with data for each employee's pay, with all the payroll details and the new year-to-date balances. Cards are also punched for labor cost distribution.
7. The final cards, completely punched, are run through a printing machine, where reports of any desired nature may be prepared, including the payroll register, the pay checks, job cost distribution sheets, job costs, and departmental cost sheets.

Point-of-Transaction Recorders. One of the most expensive operations in the use of an electronic data processor is the preparation of the media which feed information into the machine. **Punched cards, magnetic tapes,** or **punched paper tapes** are among the most frequently used methods of preparing labor cost or payroll data for the machine.

The timekeeper sometimes uses a small punching machine in the plant to cut punched cards, to prepare the tapes directly, or even to transmit data to the electronic machine by use of direct wire connections. When the timekeeper cuts a punched tape directly at the point of recording attendance time or employee job time, considerable savings may be affected. The tapes may then be run through the **electronic computer** at the end of each day for computation of labor costs and distribution of these costs to jobs, as well as computation and preparation of labor efficiency and departmental labor reports. The punched tapes contain the same data that a punched card would contain.

Bell (A Management Guide to Electronic Computers) describes the use of point-of-transaction recorders and the method of compiling payroll or other data.



INTERNATIONAL ELECTRIC MANUFACTURING COMPANY

ANALYSIS OF MANUFACTURING EXPENSES AND BUDGET

CLASSIFICATION OF ACCOUNTS
100 – MAINTENANCE & REPAIRS
200 – INDIRECT LABOR
300 – GENERAL SUPPLIES
400 – SHOP SALARIES
510 – GENERAL EXPENSE
520 – DEFECTIVE MATERIAL & WORK
550 – LIA GROUP & SOCIAL SECURITY INS
580 – VACATION
600 – WATER LIGHT HEAT & POWER

Dept ______
Period ______
Direct Labor Week ______ Year to Date ______

% TO DIRECT LABOR: EXPENSES DIVIDED BY DIRECT LABOR
% OF REALIZATION: BUDGET FOR YEAR TO DATE DIVIDED BY EXPENSES FOR YEAR TO DATE

ACCOUNT NUMBER	EXPENSES FOR THE WEEK ENDING	% TO DIRECT LABOR	BUDGET FOR THE WEEK ENDING	DIFFERENCE BETWEEN BUDGET AND EXPENSES FOR WEEK	EXPENSES FOR THE YEAR TO DATE	% TO DIRECT LABOR	BUDGET FOR THE YEAR TO DATE	% OF REAL. FOR YEAR
100								
111	77 89	9 22			960 50	10 11		
114	13 22	1 56			168 28	1 77		
121	276 53	32 71			3324 34	34 99		
171	2 52	29			18 24	19		
	370 16*	43 78	575 75	205 59	4471 36*	47 06	7452 10	166 66

DETAIL COST STATEMENT

DATE ______

5037 FUEL VALVE SEATS 61638 25 25

ORDER NO	ACCT.	PAGE	LINE	MATERIAL CODE CLASS OPER.	MATERIAL CODE ITEM	DRAWING NO G R L	DRAWING NO ITEM	DRAWING NO PART	R	ASSEMBLY NO GROUP	L / P G	ITEM	PART HOURS	R	QUANTITY	MATERIAL	LABOR	FACTOR	TOTAL
5037	531		PC	823	37						1	1			25	62 50			62 50
5037	530		1	01		231	32696	1			1	1	502				1 40	2 80	4 20
5037	530		1	01		231	32696	1			1	1	1 35		25		9 45	18 90	28 35
5037	530		1	02														11 20	16 80
5037	530		1	02														9 72	14 58
5037	530		1	03														90	1 35
																	*	43 52 *	127 78 *

OVERHEAD BUDGET REPORT

PERIOD ENDING ______ 19__

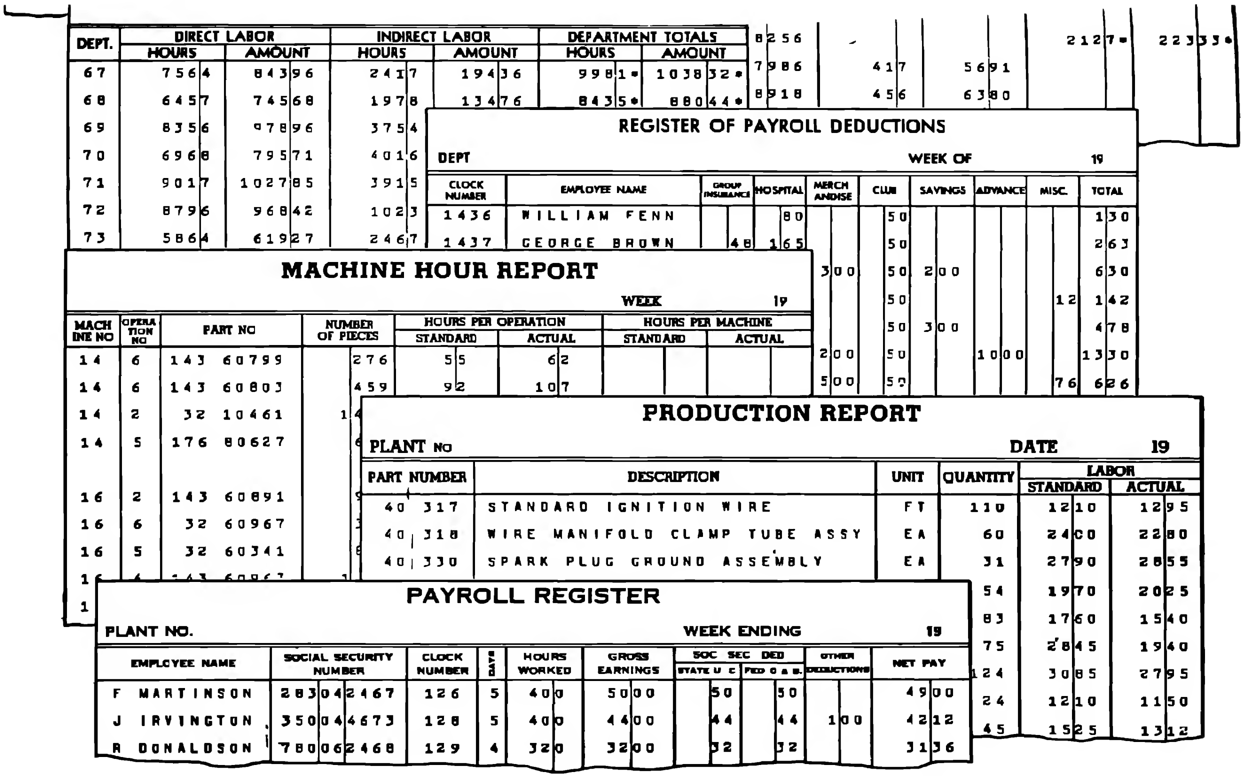
DEPT	DESCRIPTION		EXPENSE AMOUNT	BUDGET AMOUNT	VARIANCE THIS WEEK	VARIANCE CUMULATIVE
1	CUTTING	1	46 77	49 19	2 42–	39–
2	PRESS ROOM	2	283 41	303 70	20 29–	50 00
4	TUBE	4				
5	STOCK ROOM	5				
5	SHIPPING	6				
7	FITTING	7				
9	PACKING	9				

PIECE WORK ANALYSIS

WEEK ______ 19__

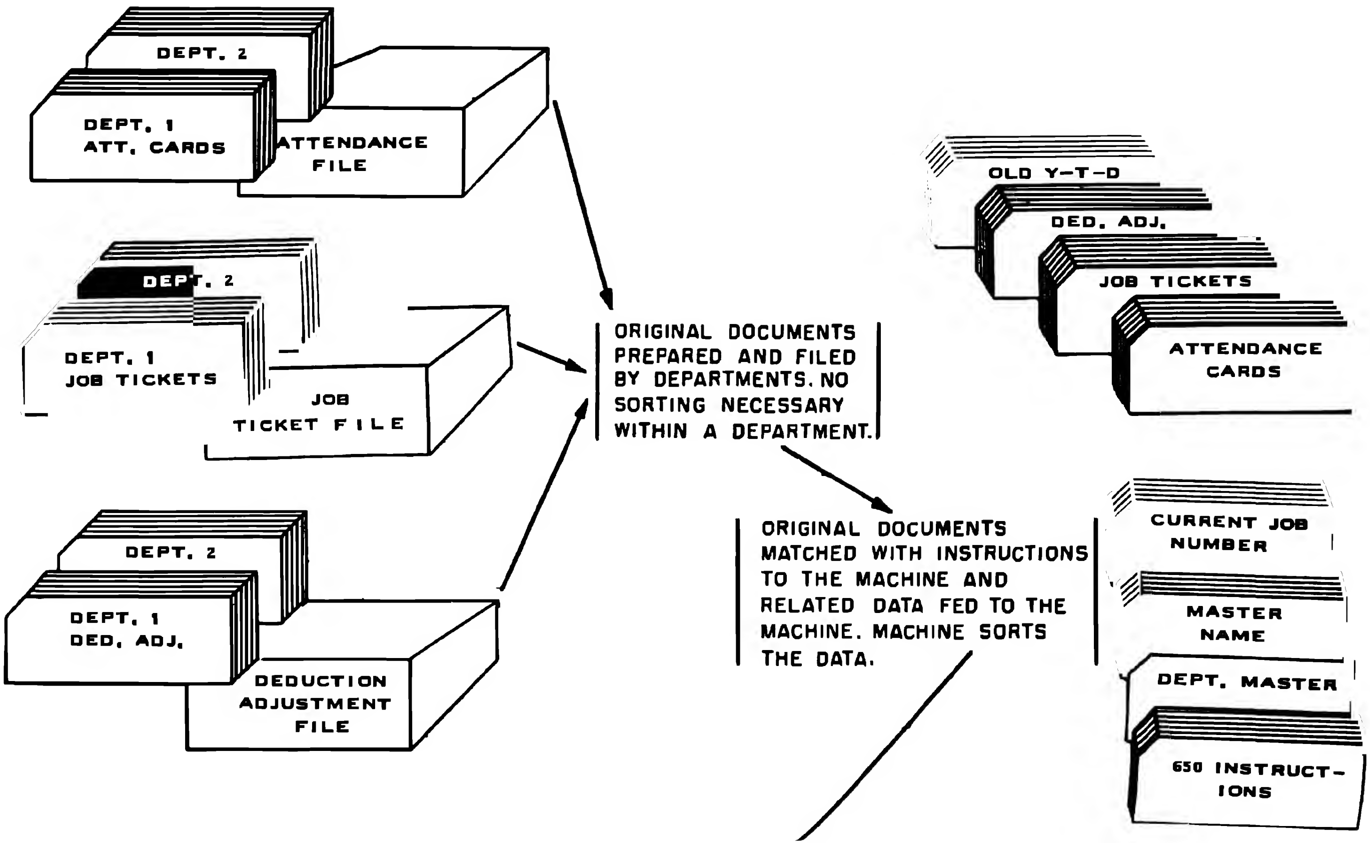
PART NUMBER		OPERATION	OPERATION TOTALS PIECES	OPERATION TOTALS HOURS	OPERATION TOTALS AMOUNT	PART TOTALS HOURS	PART TOTALS AMOUNT
1327	143	2	8719	42 3	43 60		
1327	143	3	8642	83 2	88 15		
			8594	43 0	44 69		

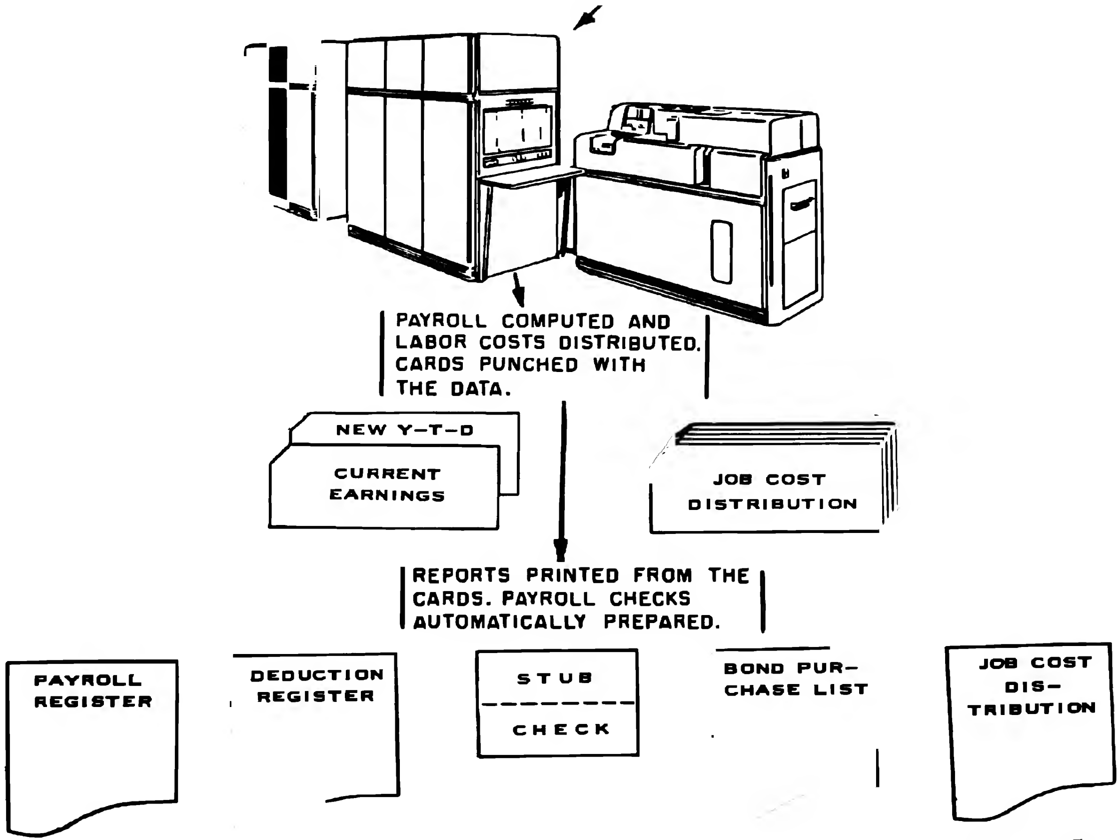
LABOR ANALYSIS



International Business Machines Corp.

Fig. 22. Payroll and labor reports prepared from punched-card time tickets and related data.


DEPT. 2
DEPT. 1
ATT. CARDS
ATTENDANCE
FILE
DEPT. 2
DEPT. 1
JOB TICKETS
JOB
TICKET FILE
DEPT. 2
DEPT. 1
DED. ADJ.
DEDUCTION
ADJUSTMENT
FILE
ORIGINAL DOCUMENTS PREPARED AND FILED BY DEPARTMENTS. NO SORTING NECESSARY WITHIN A DEPARTMENT.
ORIGINAL DOCUMENTS MATCHED WITH INSTRUCTIONS TO THE MACHINE AND RELATED DATA FED TO THE MACHINE. MACHINE SORTS THE DATA.
OLD Y-T-D
DED. ADJ.
JOB TICKETS
ATTENDANCE
CARDS
CURRENT JOB
NUMBER
MASTER
NAME
DEPT. MASTER
650 INSTRUCT-
IONS



International Business Machines Corp.

Fig. 23. Electronic data processing of payroll and labor cost distribution.

Each employee will have an identification card carrying his name, number, department, and other pertinent information. As an employee is assigned to a particular job, he will be given another small document identifying the particular job, work orders involved, lots, and other pertinent labor-control data. As he starts work on the job, he will insert the two documents—one with his personal identification, the other with job identification—into a small automatic reading device located near his work station. Data from the two records will be transcribed automatically onto a continuous tape record. When the individual finishes his job, he will repeat the recording operation. The continuous record will be taken later to a central computer, where starting and stopping time for the same employee numbers will be correlated, and elapsed time calculated for each. These data then will be summarized in order to compile payroll data, job-distribution costs, departmental summaries, etc.

Supplementary or Fringe Wage Costs

DEFINITION OF FRINGE WAGES. The Chamber of Commerce of the United States, in its biennial studies (Fringe Benefits), observes:

There are wide differences of opinion regarding just what constitutes fringe benefits, and how they should be computed. . . . [These] differences . . . indicate the need for a generally accepted definition of fringe benefits, and for a uniform method of comparing fringe benefits with employee compensation.

In an attempt to fill the need for a uniform definition, an NAA Research Project Committee (NAA Research Series No. 32, Accounting for Labor Costs and Labor-related Costs) formulated and recommended a definition of **labor-related costs** (rather than fringe benefits), which is quoted earlier in this section under Labor-related Costs Defined.

Sargent (Fringe Benefits: Do We Know Enough About Them?) suggests a three-way breakdown of labor and labor-related costs along the following lines:

1. **Wages,** which include the regular payments for employee services at straight-time and at premium rates and in accordance with bonus and incentive plans. These are payments for services which primarily benefit the employer.
2. **Wage supplements** (fringe benefits) involve payments without any directly associated effort by the employee.
3. **Wage overhead.** This is the residual category and includes all other costs associated with the employment and use of labor beyond wages and wage supplements. This includes such items as the cost of the personnel department and activities and facilities for employee entertainment and recreation.

Sargent believes that to be included as a wage supplement (or fringe benefit) an item should do all of the following:

1. Increase the total labor cost to the employer.
2. Increase directly or indirectly the monetary income of the employees. This increase is unrelated to any direct increase of effort or service on the part of the employee.
3. Benefit the employee directly and primarily.

A comprehensive listing of all payments which could be classified as supplementary wages is difficult to prepare because of the varied nature of the payments among different companies and the difference of opinion as to what should be included. The Economic Research Department of the Chamber of Commerce of the United States (Fringe Benefits) classifies fringe wages into five broad classifications:

1. Legally required payments, such as payroll taxes and workmen's compensation.
2. Voluntary payments, such as group insurance and pension plans.

3. Paid rest periods, lunch periods, wash-up time, travel time, etc.
4. Payments for time not worked, such as holiday, vacation, and sick pay.
5 Miscellaneous items, such as profit-sharing payments, service awards, and payments to union stewards.

COMPUTING TOTAL LABOR COST. The total labor cost includes both the basic wage and the supplementary wages paid to, or accruing to, the benefit of the employee. For managerial and accounting purposes it is necessary to know this **full wage cost.** Goode (NAA Bulletin, vol. 36) states that:

Basic industries have been beset with hidden wage costs in the guise of "fringe benefits," plus an extensive list of premium payments for services rendered. . . . In brief, accurate wage cost determination has become a most important function of accounting and management in the motor carrier and other industries. The added wage costs have become so substantial in amount that they will be the difference between profit and loss if they are not properly accounted for.

Goode offers a formula (Fig. 24) for determining the full wage cost:

WAGE COST FORMULA

	Wage Cost		
	Per Year	Per Day	Per Hour
Primary wage costs:			
Basic wage	$	$	¢
Social security taxes			
Compensation insurance			
4. Total primary wage costs	$	$	¢
Fringe benefit and added wage costs:			
Vacation allowance	$	$	¢
Holiday pay			
Health, welfare, and pension			
Other added wage costs			
Overtime increase due to rate change			
(Itemize)			
5. Total fringe benefit and added wage costs	$	$	¢
Total wage cost (day shift)	$	$	¢
Night shift bonus			
Total wage cost (night shift)	$	$	¢
Total wage costs per year	$	$	¢

Fig. 24. Determination of full wage cost.

PREMIUM PAYMENTS. Premium payments usually take the form of additions to base pay for the performance of undesirable tasks or as compensation for the inconvenience of undesirable working hours. Premiums may be paid for work performed in excess of a prescribed number of hours per day or per week, for night work, Sundays and holidays, and for the performance of hazardous tasks. The **shift differential** premium is usually paid for shifts worked in other than daylight hours. It is sometimes stated in terms of a flat amount, such as 10 cents per hour, $1.00 per day, or $3.00 per week, and sometimes in terms of number of hours worked, such as seven hours' work for eight hours' pay. **Extra-hazardous** premiums are paid for work that entails hazards beyond the normal in the industry, such as a truck driver when carrying a load of explosives, or con-

struction workers working more than 20 feet above the ground. **Overtime** and **holiday** premiums are paid when work is performed over a fixed number of hours per day or per week or on declared holidays.

A fundamental conflict exists concerning whether to charge premium payments directly to the product or to charge the period (i.e., Profit and Loss). The question is important because it involves principles of inventory valuation as well as the distribution of profits and losses between fiscal periods. The principle seems to be well established that all nonrecurring or extraordinary items are to be excluded from inventory costs. Therefore, if the premiums paid are **extraordinary and nonrecurring,** they should be excluded from inventory costs; if they **occur regularly,** the cost should be included. Conditions in most companies are such that payment of some form of premiums is practically inescapable, and the current trend is toward considering premiums a part of normal operating costs. The Accountants' Handbook (Wixon, ed.) states that the treatment of overtime premiums as period costs is seldom justified because such treatment destroys the comparability of figure data between accounting periods.

Charging Premiums to Products. There are two fundamental methods of charging premiums to products: (1) The premiums paid may be treated as an integral part of the base wage and charged to the same products as that base wage. (2) The premiums may be treated as an overhead item to be spread to all products through the allocation of general burden. The reasons for incurring the premium costs are the determining factors. If the premium is paid because of a specific job or contract, the cost should be charged directly to the products involved; but if the premiums are a result of general business activity, they should be charged to all products manufactured. The type of product manufactured also affects the treatment of premium costs, for in a plant engaged in a single large project, all premiums may easily be charged to the project; but when workers are engaged in a large number of smaller jobs, it becomes difficult to determine the exact job which should receive the charge for premiums paid. Neuner (Cost Accounting) states:

> It must be remembered that the type of product manufactured frequently determines the treatment of this cost. In a shipyard, it is a simple matter to allocate overtime costs directly to the job. If, on the other hand, a variety of products are being manufactured, it is not so simple. The particular job being worked on in overtime may just be a matter of chance, and therefore distorted costs result if this job is penalized. There seems to be a growing tendency, however, to include all overtime premiums in manufacturing overhead or to spread them by including them in standard costs rather than penalizing the job "caught" in the overtime. Care should be taken in the treatment of overtime if manufacturing overhead is applied to production on the basis of a percentage of labor costs, for in such cases the bonus payment arising from overtime must not be included in the direct labor costs. Similarly, if manufacturing overhead costs are applied to production on a labor hours basis, care must be taken that only the regular hours are used (not the time and one-half hours) in applying the manufacturing overhead.

NAA Research Series No. 32, Accounting for Labor Costs and Labor-related Costs, says:

> It seems preferable to exclude from direct labor cost all costs of supplementary benefits including overtime premium and shift premiums. . . . Direct labor also constitutes a better base for allocation of overhead costs when such items are excluded. Since overtime and shift premiums do not apply uniformly to all time worked, inequitable allocations of overhead may result if these supplementary costs are

included in the direct labor base. Under some circumstances, certain labor-related costs (including overtime and shift premium) may appropriately be charged directly to individual production orders or products. However, this can be accomplished without including the supplementary cost in direct labor cost.

Premiums paid to **indirect workers** are almost universally considered overhead items. This method has gained widespread acceptance because it can be used in standard, process, job order, or any other cost technique. Moreover this method can be used whether premium payments are considered production costs or period costs. By inclusion of premium payments when the **overhead application rate** is computed, these costs are automatically applied to production, or as much so as any other overhead item. If not included in the overhead allocation rate, they will be closed to the period's profit or loss through the under application of overhead.

OLD AGE AND SURVIVORS' INSURANCE AND UNEMPLOYMENT COMPENSATION INSURANCE. The Social Security Act of 1935 established a federal pension plan jointly financed by employer and employee contributions. The Act further provided for an unemployment compensation insurance plan to be administered by either the state or federal government. The rate for Old Age and Survivors' Insurance (frequently abbreviated OASI, FOAB, or FICA), which was effective January 1, 1959, is 5% of the first $4,800 earned by an employee with each employer during a calendar year. One-half, or 2½%, is paid by the employee through **payroll deductions**, and the other half is paid by the employer. Increases in these rates are scheduled for the future, but these increases are subject to change by Congress.

The **unemployment compensation insurance rate** for many years has been 3% of the first $3,000 earned by each employee with each employer during a calendar year. Of this amount, 0.3% is paid to the federal government and 2.7% to the state. However, the amount paid in to the state may be reduced by "experience ratings" or "merit ratings."

Experience Ratings. The states offer a tax reduction, based on the employment history of each employer, as an incentive to stabilize employment, implemented by a system of experience ratings. Roberts (NAA Bulletin, vol. 27) states that the experience ratings of the states are based in general upon:

1. A calculation of the ratio between the employer's payroll and the unemployment benefits paid his employees.
2. Assignment of an experience rate based upon this ratio.
3. Maintenance of a separate account for each employer for determining the adequacy of his contributions.

All employers in covered industries employing four or more employees one or more days in each of 20 different weeks during the calendar year are subject to the unemployment tax. Many definitions and provisions of a technical nature determine when an employer is subject to this tax, and reference should be made to the latest Social Security regulations for these details. The federal unemployment tax is paid yearly, on or before January 31, for the preceding calendar year, and the state unemployment taxes are usually paid quarterly.

There is some difference of opinion as to where to charge the employer's cost for these governmentally required payments. The most popular methods appear to be to include them: (1) as a part of manufacturing overhead; (2) as general and administrative expense; or (3) with the base rate as part of direct labor.

Records Required. *All employers and self-employed persons are subject to the FICA tax unless specifically excluded by the legislation.* Employers who are subject to the tax must maintain records that provide the following information:

1. Name, address, and Social Security number of each employee.
2. Total amount and date of each wage payment and period covered.
3. The amount of each payment that constitutes taxable wages.
4. The amount of the tax withheld.

The regulations do not recommend forms or details for compiling or maintaining these data, although each employer is required to keep sufficient records to enable the governmental agency to determine whether the tax is correctly computed. These records must be maintained for at least four years after the date the tax becomes due or the date when the tax is paid, whichever is later. **Quarterly returns** are required on or before the last day of the month following each calendar quarter.

The Supreme Court of the United States has ruled [U.S. v. Glen L. Martin Co., 60 S. Ct. 32 (1939)] that Social Security taxes are levied on the "right to employ." This decision appears to justify treating the cost as a general and **administrative cost.** Preferable treatment, however, would appear to be assignment to **product cost** or as a part of **manufacturing overhead.** The incurrence of this cost is a necessary prerequisite for any production that requires a labor force.

Social Security and unemployment tax costs may be charged to products either through overhead allocation or by treating them as an integral part of labor costs. The Social Security taxes add a percentage not only to direct labor costs but also to indirect labor, sales, and administrative costs. The clerical work of adding the Social Security taxes on each time ticket would be excessive in job order costing and piecework. Consequently such payroll taxes are frequently treated as manufacturing overhead.

GUARANTEED-WAGE PAYMENTS. There are three broad types of guaranteed-wage payment plans in use:

1. Wage-"leveling" plans
2. Company wage-guarantee plans
3. Income- or production-based plans

Wage-leveling Plans. These are basically **employee withholding plans** whereby some of the earnings of the employee are withheld and paid to him at a later date when his earnings are low. Usually a **norm of earnings per week** or hours of work per week is set, and all earnings in excess of this norm are withheld temporarily. Variations of this plan have been devised that make use of a **fixed wage,** paid in equal weekly amounts throughout the year. Year-end or month-end adjustments are made for the employee's excess earnings, if any, above the predetermined amount. This type of plan requires a separate payment account for each individual similar to a salesman's drawing account. When an employee's actual earnings are above the predetermined weekly wage, the excess is credited to his account; and when actual earnings are below the fixed wage, he is paid the fixed amount and his account is debited for the deficiency.

Company Wage-Guarantee Plans. These plans actually guarantee that the weekly pay check will not fall below a **minimum figure** but set no limit on how high earnings may rise during other weeks of the period. In effect the plan places a floor below the weekly wage. This type of plan does not necessitate a special account for each employee, as does the wage-leveling plan, since each employee receives each pay period either his actual earnings or the minimum guarantee,

whichever is greater. These plans are frequently funded, with **contributions** to the fund based upon a percentage of payroll.

Income- or Production-based Plans. Plans of this type tie the employee's earnings in with the income or production of the company. These are not profit-sharing plans that provide amounts of pay in addition to the base pay but are plans whereby employee compensation rises or drops as the company's income or production fluctuates. Only a complete failure of the company would cause wages to stop altogether.

The company wage guarantee is the only plan that causes costs to occur for time not worked by employees. A major costing problem arises in this case concerning proper treatment of the cost. Seiler (Accounting Review, vol. 31) states:

> Usually, as a matter of expediency, any wages paid for time not worked are entered into a separate account as paid. The question then arises as to whether this account represents a nonproduction cost which should be allocated to all production of the period. At first glance, payments made under the guaranteed wage plan for time not worked may be considered nonproduction costs, for they certainly arise because units were not being produced. Further, they may be nonrecurring costs, for they are peculiar to current economic conditions.
>
> On the other hand, there is no denying that payments made under the guaranteed wage agreement that are over and above the employee's actual earnings are costs incurred for the purpose of maintaining the labor force intact. These payments would not have been made if the company had not desired to keep its labor force together as an efficient, trained group. If production costs are to include all outlays necessary in the production of a finished product, which would include the cost of maintaining the labor force, guaranteed wage payments would then surely be considered production costs. This argument seems to be the stronger of the two, and it thus appears that these new wage costs should be treated as normal production outlays.

VACATION AND HOLIDAY PAY. The cost of paid vacations and holidays tends to occur in certain months of the year and is not incurred in proportion to productive labor. Thus **special accounting treatment** is desirable, with the end objective of charging into each month's costs approximately one-twelfth of the annual amount paid for holidays and vacations. This is frequently accomplished through the use of an **equalizing account, or reserve procedure.** An estimate of the annual cost is made at the beginning of the year, and each month an entry is made charging expense for the estimated monthly accrual and crediting the reserve account, which is frequently called "Reserve for Vacation Pay."

Determination of the **monthly expense** may be accomplished in several ways. Armor (NAA Bulletin, vol. 33) describes five methods:

1. The annual cost is estimated, based upon the prior year's payments, and one-twelfth of this is used as the monthly expense.
2. A roster of employees is prepared, showing the vacation pay and holiday pay each is to receive. The total is then reduced by a factor such as 5% to allow for employees who leave the company before vacation time. One-twelfth of the resulting figure is accrued each month.
3. A percentage of vacation and holiday pay to total payroll is computed. Each month the actual payroll is multiplied by this percentage to arrive at the estimated cost.
4. Employees are divided into groups or classes, and a percentage of vacation and holiday pay to the total earnings of each group is computed, such as 2% for employees with one week's vacation, or 4% for employees with two weeks' vacation. These percentages are multiplied by the actual earnings of each group to arrive at the estimated holiday and vacation pay cost for the month.

5. The annual earnings of each employee is estimated, including vacation and holiday pay. This is divided by the working days which the employee will actually be on the job. The result is the daily cost for that employee, and the difference between his actual earnings for the day and the daily cost is credited to the reserve account.

The entry to charge the expense account and credit the reserve is:

Vacation and Holiday Pay (Burden Incurred)	$	
Accrual for Vacation and Holiday Pay		$
(To accrue the estimated cost of holidays and vacations.)		

The entry when vacation or holiday pay is actually disbursed to employees would be:

Accrual for Vacation and Holiday Pay	$	
Cash		$
(To record payment of vacation and holiday pay.)		

The **accrual** (or **reserve**) **account** should be watched during the year to determine whether it is accruing the correct amount. Monthly adjustments may be made as necessary. Year-end balances are closed with other profit and loss accounts.

PENSION COSTS. Accounting for pension costs must be divided into two parts—that associated with past-service costs and that associated with current-service costs. **Past-service pension** cost is a term which includes that portion of the total pension liability that has been earned by the employee because of services already rendered prior to the beginning of the current pension plan. **Current-service cost** is the remainder of the pension liability which has accrued since the plan was put into effect. This part of the pension liability daily accrues to the employee's benefit as a result of his current services. It is now generally accepted that pension costs based on past service should be allocated to current and future periods and should not be charged to surplus. Past service is a partial determinant of the pension which will some day be paid, but the **pension benefits** to be derived from the plan affect current and future periods, and past-service pension costs should thus be allocated over those periods.

The AICPA Committee on Accounting Procedure (Accounting Research Bulletin No. 47) recommends that:

> . . . costs based on current and future services should be systematically accrued during the expected period of active service of the covered employees, generally upon the basis of actuarial calculations. Such calculations may be made as to each employee, or as to categories of employees (by age, length of service, or rate of pay, for example), or they may be based upon an average of the expected service lives of all covered employees. These calculations, although primarily for funding purposes, may be used also for accounting purposes. They should, of course, be revised at intervals. Also according to this view, costs based on past services should be charged off over some reasonable period, provided the allocation is made on a systematic and rational basis and does not cause distortion of the operating results in any one year. The length of the period benefited by costs based on past services is subject to considerable difference of opinion. Some think that the benefits accrue principally during the early years of a plan; others feel that the period primarily benefited approximates the remaining service life of the employees covered by a plan at the time of its adoption; still others believe that the benefits of such costs extend over an indefinite period, possibly the entire life of a plan and its successors, if any. In practice, costs based on past services have in many instances been charged off over a ten- or twelve-year period, or over a fixed longer period such as twenty or thirty years. (The minimum period presently permitted for tax purposes is ten

years if the initial past-service cost is immediately paid in full, or about twelve years if one-tenth of the initial past-service cost plus interest is paid each year.)

The AICPA Committee on Accounting Procedure (Accounting Research Bulletin No. 47), while recommending the above quoted procedure, recognizes that:

. . . opinion as to the accounting for pension costs has not yet crystallized sufficiently to make it possible at this time to assure agreement on any one method, and . . . differences in accounting for pension costs are likely to continue for a time. Accordingly, for the present, the committee believes that, as a minimum, the accounts and financial statements should reflect accruals which equal the present worth, actuarially calculated, of pension commitments to employees to the extent that pension rights have vested in the employees, reduced, in the case of the balance sheet, by any accumulated trusteed funds or annuity contracts purchased.

When a [pension] plan involving material costs is adopted, there should be a footnote to the financial statements for the year in which this occurs, stating the important features of the plan, the proposed method of funding or paying, the estimated annual charge to operations, and the basis on which such annual charge is determined.

Contributions to a pension fund, or accruals of pension liability for the current-service portion of the pension, may be treated in a number of ways. Neuner (Cost Accounting) states that **current service costs** may be:

1. Charged entirely to general and administrative expenses on the theory that it is a cost which cannot reasonably be allocated and also that it is a benefit to the entire company.
2. Allocated to the cost of each department where the employee is working. (This method penalizes the department having the oldest employees.)
3. Allocated to cost departmentally as a percentage of the total payrolls. This third method is in the form of applied overhead for the factory workers and does not penalize the department having the largest proportion of old employees. It is also comparable to the treatment of other employee welfare benefits, such as lunchroom or hospital service.

Past-service pension costs may be treated as:

1. A nonrecurring or other expense, and not as a part of operating costs.
2. A general and administrative expense, thus making it a part of the cost of administering the business, but not a part of manufacturing.
3. An element of indirect cost, allocated either directly or proportionately to departments or jobs.

Keyserling (Controller, vol. 16) found that only 36% of the companies polled in an extensive survey considered the past-service cost a period cost rather than a part of production costs. Most of these companies justified their choice of method by the fact that past-service costs benefit the company as a whole, and allocation of that cost among production, sales, administration, and other functions would be almost impossible. The remaining 64% of the companies polled by Keyserling treated past-service costs associated with factory workers as a manufacturing cost. The most common **method of allocation** was to spread the pension cost to production on the basis of total labor cost. This procedure prevented the distortion in unit costs that would have resulted by charging the past-service pension cost to departments, since departments with a larger number of older employees would have been penalized.

REPORTING FRINGE DATA. The usefulness of fringe data is frequently dependent upon its comparability with the same type of data from other com-

panies. **Intercompany comparisons of fringe data are frequently made, and sometimes a company's entire wage structure is based upon the labor agreements made by other companies in the same industry.** Several major factors enter into a meaningful **intercompany comparison** of fringe costs:

1. The accumulation of these costs must include the same items.
2. The base for computing ratios or percentages must be similar.
3. Calculations must be made in the same way.

The comparison of one company's fringe benefits at 16% of payroll with another company's 18% of payroll means little unless the type of items considered as fringe costs are the same and unless the payroll base is similar; i.e., base pay, gross pay, pay before vacation and holiday allowances, etc.

The Economic Research Department of the Chamber of Commerce of the United States in its biennial report (Fringe Benefits) shows fringe data in three different ways:

1. Percentage of total payroll.
2. Dollar costs per year per employee.
3. Cost per payroll hour per employee.

Dale (Handbook of Modern Accounting Theory) discusses the relative advantages and disadvantages of these ways of presenting costs of fringe data. He observes that the percentage of fringe benefits to total payroll (1) tends to eliminate the effect of differences in the base rate and the total payroll, so that it may be a valuable additional figure, although comparability may be damaged by variations in hours of work such as overtime. He notes that the total cost of fringe benefits per employee (2) makes an impressive and easily understood figure, although not likely to be as accurate as the more refined methods. Dale finds that cents per hour per employee (3) is a popular figure for comparison of fringe costs between companies, industries, unions, and localities and for estimating the cost of a productive hour of work. It may look rather small, however, and not provide accurate comparability over a period of time because of the variance of hours of work.

Fringe labor reports to management should contain much more detail than is commonly used for external reporting. Full information concerning the amount, type, nature, and effect on the over-all cost picture should be reported periodically to management. The Research Project Committee of the National Association of Accountants (Research Series No. 32, Accounting for Labor Costs and Labor-related Costs) recommends the form shown in Fig. 25 in reporting labor and labor-related costs to management. This form was developed after reviewing many reports in actual use.

COMPUTING THE COST OF SUPPLEMENTARY LABOR. Supplementary labor costs are often difficult to compute, due to the illusive nature of this type of expenditure. The total dollar amounts expended must frequently be isolated by means of extra analyses and cost studies. These studies are of value, however. The **basic uses of fringe data,** once compiled, may be summarized as follows:

1. Intercompany comparisons.
2. Labor negotiations with employees and unions.
3. Sharing information with employees and stockholders.
4. Computing "extra" costs of increasing the labor force.

5. Obtaining the costs of producing specific units or completing contracts.
6. Determining the cost of increasing the benefits or coverage of a particular fringe wage.
7. Determining means of controlling the cost of fringe labor.

MANUFACTURING COST REPORT—SUGGESTED FORM

Department
______________________ Plant

This Month Actual Budget Variance		Year to Date Actual Budget Variance
	BASIC LABOR COST	
	Direct Labor	
______________________	Total	______________________
______________________		______________________
	Indirect Labor	
	(Detail by accounts)	
______________________		______________________
______________________	Total	______________________
______________________	TOTAL ALL LABOR	______________________
	LABOR RELATED COSTS	
	Related to Payroll Dollars	
	Employee Welfare & Security	
	Premium Payments for Time Worked	
	Payments for Time Not Worked	
______________________	Company Policy Payments	______________________
______________________	Total	______________________
	Related to Number of Employees	
	Employee Welfare & Security	
	Company Policy Payments	
______________________	Employment Administration	______________________
______________________	Total	______________________
______________________	**Special Labor Related Costs**	______________________
______________________	TOTAL LABOR-RELATED COSTS	______________________
	MANUFACTURING EXPENSES	
______________________	(Detail by accounts)	______________________
______________________	TOTAL MANUFACTURING EXPENSES	______________________
______________________	TOTAL MANUFACTURING COST	______________________

Fig. 25. Report of labor and labor-related costs.

The Minnesota Mining and Manufacturing Company uses a form (Fig. 26) to accumulate both the total and the detail of its **fringe wage costs** (National Industrial Conference Board Reports, No. 128). These data are then reduced to a **cost per productive hour** for comparison and for trend purposes.

CALCULATION OF NET PRODUCTION HOURS

Total Hours Spent in Plant	____________
Minus: Nonproductive hours such as paid rest period, paid lunch period, wash time, clothes change, as provided in union agreement or written company policy.	____________
	____________
Net Production Hours Worked	____________

ITEMIZED ADDITIONAL BENEFITS

	Total Cost	Cost Per Prod. Hour (Total Cost ÷ Net Prod. Hours)
A. Premiums for time worked		
1. Overtime prem. incl. prem. for Sat., Sun., & Hol. worked	______	______
2. Shift premiums, PM & Night.......	______	______
Group Total	______	______
B. Pay for time not worked		
1. Sick Pay (Pd. for by Co.)	______	______
2. Vacation Pay	______	______
3. Holiday Pay (Hols. not worked)..	______	______
4. Pd. rest period & lunch period.....	______	______
5. Wash up & clothes change time pd. for	______	______
6. Jury, witness, & voting pay allow...	______	______
7. Pay for Nat'l. Guard & Organ. Reserve	______	______
Group Total	______	______
C. Employee benefits (company's contrib. only)		
1. Old Age & Unempl. Compensation.	______	______
2. Workmen's Compensation	______	______
3. Pension Plan	______	______
4. Profit Sharing, Christmas Bonus, etc.	______	______
5. Group, Life, Hosp., & Health & Accid.	______	______
6. Death Benefits (Pd. for by Co.)...	______	______
7. Food cost subsidy	______	______
8. Work shoes & clothing cost	______	______
9. Payments to Union Rep. dur. griev. & neg.	______	______
10. Administrative cost of benefits.....	______	______
11. Separation pay allowance.........	______	______
Group Total	______	______
D. Employee activities (employer's share only)	______	______
1. Service Awards	______	______
2. Athletics, Recreation & Soc. Events	______	______
Group Total	______	______
Total Cost of Additional Benefits.	______	______

Fig. 26. Form for accumulation of the cost of supplementary wages.

ACCOUNTING FOR SUPPLEMENTARY WAGES. There are two basic problems in accounting for supplementary wages:

1. Estimating the amounts applicable to each accounting period.
2. Allocating these amounts to production.

The question of whether these costs are period costs or production costs appears to have been fairly well settled, and most accountants agree that these wage costs are part of the **production cost.** Taylor (Cost and Management, vol. 27) expresses the minority viewpoint when he states that "fringe costs are a function of time and should be handled as period costs." Studies by the National Industrial Conference Board (Conference Board Reports, No. 128) indicate that almost without exception these costs are considered production costs. Since supplementary wage payments are made directly to maintain employee security and welfare, they are a virtually inescapable cost of producing goods. If **inventory costs** are to include all costs incurred directly for production purposes, supplementary wages must be included.

Supplementary Wage Cost Estimation. Estimating the costs applicable to each accounting period is relatively easy for such supplementary wage costs as social security, workmen's compensation, premium payments, vacation and holiday pay, and group insurance contributions. Since these are usually paid within the accounting period, or very shortly thereafter, the amounts may be determined with reasonable accuracy. Other supplementary costs, such as pensions, dismissal compensation, and guaranteed-wage costs are in most instances much more difficult to estimate. These costs should be accrued each accounting period, and since the full extent of the cost may not be known for many years in the future, the current year's estimate is subject to considerable error. Reliable estimates may be prepared, however, based upon past company history, the age, tenure, and pay rates of the working force, the stability of the particular industry, and the terms of the **supplementary wage agreement.**

Accounting Procedures. There are three general procedures for entering these costs into the flow of production costs, once the amount has been determined:

1. Supplementary wage costs may be treated like any other manufacturing overhead cost and may be prorated to jobs or processes through the same burden application rate as all other burden items.
2. Supplementary wage costs may be accumulated in a separate class of burden accounts and a separate burden application used for these costs.
3. Supplementary wage costs may be accumulated and charged into production along with the base wage of the employee, so that they become, for accounting purposes, only additions to the base wage.

The use of the first method, that of treating these costs like other manufacturing cost items, has the advantage of simplicity but the disadvantage of hiding these costs under the maze of other manufacturing overhead items. Also, if a rate other than direct labor cost is used to allocate general overhead, the rate may not allocate these costs in relationship to the wages that gave rise to them.

Treating supplementary costs as a separate class of overhead, with **separate allocation rates,** requires additional clerical effort but will result in more accurate costing of products. This method also tends to spotlight supplementary wage costs by giving them special accumulation and allocation treatment. Since the aggregate of fringe costs is relatively high in comparison with other manufactur-

ing overhead costs, this method is preferable to lumping supplementary wages with general overhead.

Treating supplementary wage costs as **additions to the base wage** is the most accurate method of charging these costs to production. Alexander (Cost and Management, vol. 28) advocates such a procedure, in which the "true" hourly labor cost for each employee is computed by adding the fringe to the base and charging that employee's labor costs into production according to this "true" hourly rate. This method correctly charges to production the cost of keeping the employee on the job, including the supplementary wages, during the time he works on a particular order or process. Moreover, this method tends to emphasize the over-all cost of providing supplementary wages, although the cost of individual types of fringe wages may be somewhat obscured.

Rudell (NAA Bulletin, vol. 36) describes a variation of the method of treating fringe wages as part of the direct labor cost, which will not obscure the full cost of individual fringe payments. This procedure adds a **predetermined percentage** to the base wage of each employee to cover the fringes. When this amount is added to jobs or processes with the direct labor, the offsetting credit is to manufacturing overhead. Rudell describes the procedure as follows:

> The fringe items would continue to be booked to the individual burden accounts as they are incurred (for both direct and indirect labor) by departments. The credit (when fringes are applied to jobs with direct labor) is an offset to the individual fringe costs recorded in burden. The net effect of this transaction is to leave in burden that portion of fringe which applies to the indirect labor plus the fringe cost variance which applies to the direct labor.

Labor Budgets

OBJECTIVES OF A LABOR BUDGET. Labor budgets normally include only direct labor, since indirect labor is usually included in the manufacturing overhead budget. (See section on Cost Control, Budgets, and Reports for a detailed discussion of other forms of budgeting.) The principal **purposes** of developing a detailed direct labor budget are set out by Welsch (Budgeting: Profit Planning and Control) as follows:

1. To determine the direct labor required in terms of labor hours, and hence the number and kind of workers required to meet production requirements.
2. To estimate the direct labor cost of production.
3. To provide the personnel department with personnel requirements so that it may plan recruitment activities.
4. To provide data for determination of cash requirements for direct labor.
5. To provide data for managerial control of direct labor costs.

The labor budget is based upon the **estimated production** to be undertaken in the budget period and the **projected labor costs** necessary to realize this production. A major problem in setting the labor budget is the allocation of production throughout the period covered. Production should be spread as evenly as possible over the period in order to stabilize the number of employees and keep the working force as compact as possible.

LABOR BUDGET CONSTRUCTION. Since the labor budget is basically a forecast of labor hours and the resulting labor costs, construction of the budget should begin with a determination of the number of units to be produced. This estimate should then be used as a basis for determining the number of labor hours needed. Budgeted labor costs are the result of applying rates to the

estimated number of hours. The number of units to be produced and the allocation of production throughout the period are usually determined when the **production budget** is prepared, and direct labor budgets should not be prepared until after production budgets have been set.

Determination of Direct Labor Hours. Heckert and Willson (Business Budgeting and Control) discuss four means of determining the number of direct labor hours to be incurred in the manufacture of each unit of finished product to be produced. These hours must then be multiplied by the estimated number of units in order to determine the total labor hours budgeted for the period.

1. Use of **standard hours.** This method is used when products are uniform and standard labor times have been established.
2. Use of **operation time.** When the type of products varies but the nature of operations performed on these products is fairly uniform, the time consumed in each operation may be used as the basis for determining the direct labor hours.
3. Use of **ratios of direct hours to some other measure of volume or output.** This method should be used only if actual hours or standard hours are unavailable. It should be applied in such a manner that ratios are determined for each department or for each class of product. If this is not done, analysis of budget variances loses some of its usefulness.
4. Use of **estimates.** This method is not recommended and should be used only when other techniques cannot be employed. Sometimes each foreman is asked to make his own estimates, which should then be approved by higher production executives.

(For a discussion of the learning curve technique in estimating labor costs, see the section on Estimated Costs.)

Determination of Direct Labor Rates. After the number of direct labor hours to be worked has been determined, this number must be multiplied by labor rates to determine labor costs. Heiser (Budgeting—Principles and Practice) indicates that the determination of **labor price standards** or rates varies with the type of pay plan and discusses some of these variations as follows:

If a straight day-rate or hour-rate plan is used, the problem is very much the same as that of setting a standard purchase price for material. The standard rate is that which the company expects it must pay, giving effect to local and industrial labor conditions. Commonly, today, the rates are included in the negotiated labor contract. If all the labor in a given department or operation is paid at the same rate, the price standards will be the same as the contract rates. If, however, this is not the case because of variations related to length of service, experience, and the like, then the standard must be calculated on the basis of some form of expected weighted average hourly or daily rate.

If the pay plan is related, either wholly or partially, to amount of output, as in the case of straight piece rates or bonus plans, or a combination plan, the determination of the price standard is tied in with the determination of the quantity standard. If a straight piece rate is provided for in the labor contract, the negotiation of the rate involves, in effect, the negotiation of both price and quantity. This rate sets the standard labor cost per unit of output.

If, on the other hand, price and quantity are negotiated in connection with some form of premium or bonus plan, an additional step is needed in setting the standard labor price per piece because of the variability of the unit labor cost under different conditions of output. These plans, depending on their nature, provide for either increasing or decreasing unit labor costs as output per worker (or group of workers) increases. Furthermore, the increases or decreases may be curved or stepped in

nature. The problem of setting a price standard therefore becomes one of setting a standard output per worker. Hence, price and quantity both are involved in setting the price standard.

Two different practices are used in setting labor price standards under premium or bonus plans: (1) setting the standard at the wage rate paid for the 100% level of output, assuming that this level is reasonable, or (2) setting the standard on the basis of the average bonus or premium earned, assuming that this will be consistent.

LABOR BUDGET REPORTS. Budget reports covering labor costs take a variety of forms and may be prepared daily, weekly, or monthly. To be most useful, the reports must be **comparative,** showing the difference between budgeted or standard labor and actual labor costs. Most budget reports also show the budget **variance** on a cumulative basis for the entire budget period. These reports should be sent to all personnel responsible for labor performance, including department heads and foremen. Thus, if budgeted labor costs and actual labor costs are reported by departments, and by products or jobs within each department, the persons responsible for labor performance will be informed with sufficient detail to permit them to deal effectively with situations requiring **labor cost reduction.** Heiser (Budgeting—Principles and Practice) emphasizes the detail required in labor budget reports if they are to prove useful:

> The varied causes and sources of variations . . . call for a good reporting of labor performance. A variance in one department may be unavoidable because of failures elsewhere in the organization. Corrective action may have to be initiated at a higher level of management than the departmental level because of the interlocking nature of interdepartmental activities. . . . Because of the many possible reasons for variations from standard time, the accurate reporting of them frequently is difficult but, nevertheless, important.

See section on Analysis and Control of Standard Cost Variances for form from NAA Research Series No. 22 (NAA Bulletin, vol. 33). This shows the amount and the causes of the variance of actual cost from standard, both for the current month and year to date.

SECTION 7

ACCUMULATION OF MANUFACTURING OVERHEAD

CONTENTS

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SECTION 7

ACCUMULATION OF MANUFACTURING OVERHEAD

Definitions

MANUFACTURING OVERHEAD. Manufacturing overhead includes all production costs, except direct materials and direct labor; it is composed of all the **indirect manufacturing costs** which cannot be traced to specific units of production. For example, in the production of a piece of furniture, it is possible to ascertain the cost per unit of the lumber and other direct materials as well as the cost of the direct labor time spent in the actual production of each unit. However, the cost of supervisory and custodial labor, insurance, and other building costs cannot be traced directly to any specific unit of the product. In this sense, overhead is a cost common to several units of production. Also included in manufacturing overhead are some **direct costs** which are so small in amount that it is inexpedient to trace them to specific units of production. Certain direct materials such as screws, bolts, glue, and metal skids could be traced directly to the product, but the cost may be so insignificant that it would be inexpedient to do so.

While the cost accountant considers manufacturing overhead to be identical with indirect manufacturing costs, the economist looks upon overhead as a term synonymous with **fixed cost of production.** In accounting terminology, overhead has both fixed and variable cost components. Clark (Studies in the Economics of Overhead Costs) states that the term

> . . . covers an entire family of ideas, but they have one essential thing in common. They refer to costs that cannot be traced home and attributed to particular units of business in the same direct and obvious way in which, for example, leather can be traced to the shoes that are made from it. And most of the real problems involve one other fact; namely, that an increase or decrease in output does not involve a proportionate increase or decrease in cost.

SIMILAR TERMS. Such terms as **overhead expense, burden, manufacturing expense, indirect expense, indirect manufacturing cost, indirect manufacturing expense, factory expense, factory overhead, loading, supplementary costs,** and **oncost** have been used interchangeably with the term "manufacturing overhead." Blocker and Weltmer (Cost Accounting) present the following case for the use of the term **manufacturing overhead**:

> The word overhead is preferred to burden and supplementary costs because the latter terms signify an unnecessary charge, an extra cost or an element of cost resulting from inefficiency. The terms have been inherited from the handicraft stage of production in which the elements of material and labor were of primary importance and the use of capital in the form of machinery and plant was insignificant. The term overhead is preferred to manufacturing expense because the latter term is often applied to all manufacturing costs, both direct and indirect. Overhead may be used for all types of business enterprise while the term manufacturing expense is restricted in its use to manufacturing concerns.

Blocker and Weltmer observe that "indirect expense" is an expression which implies that certain costs are invisible or unaccountable.

On the other hand, Dohr and Inghram (Cost Accounting Principles and Practice) indicate a general dissatisfaction with the terms in use, suggesting the term **factory service** as being more descriptive of manufacturing overhead. These authors believe that overhead costs are necessary and incident to the maintenance of a properly equipped and properly operated factory or plant and therefore are as necessary for production as is the cost of direct labor and materials. The element of factory service in cost represents the charge for the use of the plant capacity.

As indicated above, overhead is sometimes thought of as an unfortunate addition to the real costs of production; in this sense, it is a type of **nonproductive cost**. It is fairly common, for example, to find indirect labor referred to as nonproductive labor, although the undesirability of the term "nonproductive" is now rather generally recognized. The use of the adjective "nonproductive" in connection with overhead is misleading because of the implication that such items make no contribution to the manufacturing activity. Some authors point out that the overhead cost associated with **idle capacity** should be treated as a loss rather than a cost of the product, but this distinction does not alter the fact that overhead costs are real costs and in general are necessary for the operation of the factory.

MANUFACTURING OVERHEAD TRENDS. The importance of manufacturing overhead as a component of production costs depends on the type and the size of the enterprise as well as the type of product produced. In the old **handicraft type of production**, overhead cost was not important inasmuch as this methodology was characterized by little capital investment and unspecialized labor. Furthermore, the workman was primarily concerned with the conversion of a raw material into a finished product where both the raw material and the cost of labor were the expensive elements of cost.

In seeking the economies of **large-scale production**, manufacturing enterprises have grown in size, and this has resulted in a high degree of labor specialization and large capital investments. At the same time, firms have diversified their product lines to the extent that thousands of different types of products are manufactured. All these influences have caused the emergence of a large body of common production costs which are now called manufacturing overhead.

As the trend develops toward more plant **automation**, the amount of overhead costs will become even more important. This shift from human to machine production will continue to lessen the importance of labor cost and increase the importance of machine or common costs. At the same time, the introduction of automation will result also in more **fixed cost**. Consequently the accountant's definition of manufacturing overhead (whereby overhead is looked upon as indirect or common costs) may change and resemble more closely the economist's definition of overhead (whereby overhead is looked upon as a fixed cost of production).

Vance (Theory and Technique of Cost Accounting) summarizes the impact of automation as follows: "Overhead costs are as large as the cost of direct materials and labor in many modern enterprises due to the use of elaborate and expensive equipment. The use of such equipment makes possible a large volume of production at a low cost per unit, but it also necessitates an accounting which may become very involved." The involved accounting referred to by Vance arises primarily from the increased common or overhead costs.

Manufacturing Overhead Accounts

PRIMARY MANUFACTURING OVERHEAD COSTS. Manufacturing overhead costs are generally classified into the three primary groups of indirect materials and supplies, indirect factory labor, and other factory costs.

Indirect Materials and Supplies. The cost of factory materials which cannot be assigned to any specific unit of product is charged to manufacturing overhead cost. The indirect materials cost may be common to several units of product, or it may be the cost of direct materials which is so small or complex that direct tracing is inexpedient. Examples of such direct materials are glue, thread, nails, and rivets.

The term **factory supplies** is often used interchangeably with indirect materials or factory materials. In some cases a technical distinction is made, however, in which the term "indirect materials" is reserved for items used in the manufacturing operations, such as abrasives and the direct materials too small to trace to individual products. The term "factory supplies" then is used to cover items that contribute to keeping the plant in good working condition, such as lubricants for the machinery and janitorial supplies for cleaning the plant.

The following example of the numerous items included in indirect materials and supplies is taken from the Uniform Accounting Manual for the Electrical Manufacturing Industry (National Electrical Manufacturers Association):

Acids	Chaplets	Graphite
Alcohol	Core oil	Greases
Ammonia	Core rods	Hinges and hasps
Automobile supplies	Core wash	Hooks and eyes
Barrels	Cotton cloth	Lead, white
Basins, small wash	Cutting compounds	Matches
Baskets	Dippers	Molding sand
Beeswax	Drilling soap	Mops
Belt cement and dressing	Dusters	Paste, mineral
Belting, cotton	Emery	Rope, hemp
Benzine	Facing, foundry	Sal soda
Blowhole cement	File brushes	Tacks
Brooms	Fire clay	Tool boxes
Buckets	Flour, emery	Window cleaners
Carborundum, grain	Flour, foundry	Wire brushes
Chalk	Gate hooks	Wood, kindling
Chamois	Gloves	

Indirect Factory Labor. In many firms the cost of a large portion of factory labor cannot be assigned directly to any specific product. This common labor cost is called "indirect factory labor" and is included in the manufacturing overhead. Lang–McFarland–Schiff (Cost Accounting) state:

> Indirect labor represents auxiliary work done in connection with product manufacture. It is labor not identifiable with the cost of a specific product, but which performs essential services. It includes all labor in service departments as well as auxiliary labor in producing departments.

Also included in indirect factory labor are some **direct labor costs** which, like some direct materials costs, are not assigned directly to the unit of product. The employer's **social security charge** as well as **unemployment payroll taxes** are frequently charged to overhead even though a share of these costs is attributed to direct labor. Schlatter and Schlatter (Cost Accounting) justify this

procedure by pointing out that if these taxes were charged to direct labor, the early jobs would bear the full tax rate while the later jobs would bear none. This situation occurs because the tax does not pertain to wages over a specified sum. For example, the current social security tax (FICA) is paid only on the first $4,800 of earnings per year. By charging the tax to overhead and using a **pre-computed overhead rate** based on a forecast for the coming year, each job is assigned cost at the same rate.

Charges for overtime premium or bonus (the extra payment made because the time worked was in excess of the regular working period) is an example of another cost which is usually charged to indirect factory labor. This practice is usually followed regardless of whether the overtime premium is paid to a direct or indirect laborer. Another charge of the same type is a **premium for night shift labor.** This practice is justified where the general volume rather than one particular job creates the overtime or night shift premium. If such a premium is created by one particular job, the cost should be assigned directly to that job rather than accounted for as manufacturing overhead.

The following example of some **indirect labor costs** is adapted from the Basic Cost System for Gray Iron Foundries (Gray Iron Founder's Society, Inc.):

Foremen and assistants
Clerks
Furnace helpers
Furnace chargers
Melters
Shake-out labor
Clean-up sand
Flask fitters
Ladlemen and helpers (pouring from shank ladles)
Gaggermen
Pattern and core carriers
Pattern estimators
Other pattern labor
Oven tenders, dry mold ovens
Ladle repairing
Sand mixing, milling and reclaiming
Engineers
Firemen
Watchmen and janitors
Truck drivers
Maintenance inspection
Cranemen
Making gages and templates
Weighmen
Runner-cup makers
Tool tenders
Pouring labor, bull ladles
Core pasters
Oven tenders, core
Plate handlers
Sand delivery
Oven tenders
Loading and unloading ovens
Apprentices
Process inspection
Departmental trucking
Chainmen
Taking inventory
Core carriers
Tumbling-barrel labor
Sand blasting
Salvage welding
Salvage straightening, press operators
General labor
Idle time
Vacations and sickness (salaried employees)
Allowances and overtime premiums

For further discussion of indirect labor, see section on Labor Costs.

Other Factory Costs. Other factory costs include a variety of **production costs** which are difficult or impossible to classify under any other category. Neuner (Cost Accounting) states that this group of costs is so broad that sub-classifications are necessary. He recommends the following classifications:

1 **Maintenance**
Building maintenance
Machinery and tool maintenance
Furniture and fixture maintenance
Transportation system maintenance
Patterns
Auto and delivery equipment maintenance

2. **Fixed Charges**
   - Depreciation
   - Taxes
   - Insurance
   - Shop vacations
   - Group insurance
   - Taking inventory
   - Pensions
   - Rentals

3. **Power, Heat, and Light**
   - Operating employees
   - Operating supplies
   - Maintenance of equipment
   - Fixed charges

4. **Special Service Department Costs**
   - Purchasing department
   - Receiving department
   - Storeskeeping department
   - Cost accounting department
   - Medical department
   - Cafeteria department
   - Police and protection

5. **Sundry Overhead Costs**
   - Royalties
   - Apportioned administrative expenses
   - Special taxes, such as payroll, processing, and even income taxes
   - Interest on investment (when used)
   - Defective material losses
   - Spoiled goods
   - Direct material inventory losses

CONTROVERSIAL MANUFACTURING OVERHEAD COSTS. A divergence of opinion exists among accountants and managers in industry with respect to certain manufacturing overhead costs, which are:

1. General administrative costs.
2. Interest on investment.
3. Depreciation on replacement cost.
4. Research and development costs.
5. Supplementary labor costs.
6. Taxes.

GENERAL ADMINISTRATIVE COSTS. There are conflicting opinions over the proper accounting for general administrative costs. As pointed out in the NAA Research Series No. 10 (NAA Bulletin, vol. 28), the traditional approach has been to view administration as a separate function on the same level as manufacturing and selling. Consequently, since **inventories,** by convention, are charged with manufacturing costs only, rather than the total costs of running the business, the administrative cost is said to be a cost of the period and not of the product.

A second viewpoint is that the two basic functions of the business are selling and manufacturing and that general administrative costs are incurred for the benefit of both these functions; consequently, part of the administrative cost should be assigned to the product through manufacturing overhead. Some persons who subscribe to this viewpoint, however, limit the extent to which they would apply general administrative costs to inventories because of the difficulty of apportioning such costs between period and product costs. (For a detailed presentation of the arguments for and against the division of administrative costs between manufacturing and selling, see section on Cost Classifications.)

Administrative and Selling Costs. More confusion and controversy arises when selling costs are considered. Many accountants discuss the problem of administrative costs together with selling costs and advocate that part of these costs should be charged to the product. Goetz (Management Planning and

Control) states: "Usually only 'production expenses' are charged to work-in-process inventory accounts as direct materials, direct labor, or overhead, but the suggestion has been repeatedly made that all overhead, including selling and administrative, should be allocated to specific products." According to Goetz, the chief reason for not attempting to allocate such costs to product has been the difficulty of finding a satisfactory basis for allocation.

Current and Deferred Costs. The problem of selling and administrative costs is further complicated by the variety of costs included in this classification. There are some selling and administrative costs which are clearly **period costs** and thus should be charged to expenses of the current accounting period; and there are other selling and administrative costs which are clearly of benefit to future accounting periods and should be deferred through an asset account. The **asset account,** however, need not be the inventory account; consequently, manufacturing overhead need not be affected.

The cost of maintaining and operating an **industrial relations division** within the business is an administrative cost. Part of this cost benefits the manufacturing operation and part benefits the selling organization. Consequently a part of this cost should be considered manufacturing overhead and should be charged to the production for the period. The chief obstacle here is the measurement problem.

On the other hand, the legal fee paid to a lawyer to obtain a **patent**—if it is considered an administrative cost—should be deferred but not through manufacturing overhead. The initial charge should be made to the patent account, and only part of this charge should be considered as manufacturing overhead of the current period.

The same problem arises regarding selling costs. Most selling costs, if they are of future benefit to the firm, should be charged to asset accounts other than inventory. **Advertising** is such an example. Again the chief obstacle is in finding a suitable basis for measuring the future benefit. Other selling costs such as salesmen's commissions are clearly operating expenses. Selling costs incurred to obtain an order or contract in advance of the actual production of the goods, however, might be included as part of the inventory cost of that order. Lawrence (Cost Accounting, revised by Ruswinckel) states: "A very large number of manufacturing companies make their product to order, and a great amount of expense is undertaken in order to sell products that are not in existence at the time of sale. It is not considered improper to defer an expense that will result in future benefit." He recommends that this selling cost be deferred by inclusion in the inventory value that has resulted, at least in part, from the selling effort.

Vance (Theory and Technique of Cost Accounting) summarizes the problem of selling and administrative costs as follows:

> It is pointed out that factory overhead was not applied to products a few decades ago, the belief being that only direct materials and direct labor could legitimately be shown as assets. Application of selling and general costs to product is therefore said to be the next step forward. However, factory overhead was formerly small in comparison with direct materials and labor, so its treatment in the past was not so important as it is now. Once again, it is partly a question of the evidence necessary to justify a charge to an asset. It is by no means always certain that selling and administrative expenses can be recovered in sales, and, if they cannot, they are not justifiably charged to assets. Even though manufacturing costs are charged to inventory accounts, they are written down if they cannot be recovered in sales. The present conclusion is that factory costs are sufficiently likely to be recovered to justify carrying them as assets until the goods are sold, and that selling and admin-

istrative costs are not. A very great improvement in business stability would be required to change this conclusion, and costs incurred after sale of the product would still represent a doubtful category. It is assumed that costs of cost accounting, factory personnel offices, and so on, which are readily identifiable as part of manufacturing activities, are accounted for as factory office costs and included in factory overhead.

Many concerns calculate the average percentage that selling and administrative expenses are of sales and use this percentage to calculate the selling and administrative expenses attributed to each job. The figure is noted in the "summary of cost" on the job cost sheet, and net operating profit on the job is calculated. This calculation is made for memorandum purposes only; since it is based upon a very broad average, it may be misleading.

INTEREST ON INVESTMENT. The question of whether or not interest on investment is a proper manufacturing overhead cost has not been definitely settled. The interest in question is not the interest paid on borrowed money but an **imputed charge** on the investment in plant facilities and other assets necessary for the manufacture of the products. Basically this imputed interest charge is an **opportunity cost**; that is, if the capital had not been devoted to the production of the current period, it could have been devoted to another use which would have provided the firm with income. This opportunity income creates an opportunity cost to the firm, and the question arises as to whether or not such a charge should be included in manufacturing overhead. It appears that very few firms enter imputed interest in their accounts, but apparently many use it in off-the-record computations in problems of alternative choice, such as whether to buy a new type of machine or to continue an old operation.

Interest and Overhead Costs. Lawrence (Cost Accounting, revised by Ruswinckel) gives the following reasons for inclusion and noninclusion of interest as a manufacturing overhead cost:

Reasons for inclusion.

1. To have accounting follow the economic concept of cost.
2. To permit measuring of the relative economy of methods or machines.
3. To prove the correctness of preliminary estimates.
4. To distinguish between kinds of businesses or lines of sales in determining the profitableness of each.
5. To show for different departments the cost that arises from the use of capital.
6. To account properly for the time element in cost.
7. To determine the cost of capital in relation to large or small inventories.
8. To show when it is cheaper to buy or to manufacture parts of the factory product.
9. To compare the cost of owned with rented or leased plants.
10. To weigh different methods of financing.
11. To secure uniform cost methods in trade associations.
12. To provide an inducement for increased production.

Reasons for noninclusion.

1. Accounting cost need not be reconciled with economic cost.
2. Interest on investment does not represent an actual outgo and therefore is not a cost.
3. Inclusion of interest on investment in cost inflates inventories and anticipates profit.
4. Interest is not necessary for the comparison of different methods.
5. If it is desirable to know the amount of interest in cost, it can be secured without putting it in the accounts.
6. It is impracticable to determine on what investment the interest should be computed or what rate of interest should be used.

7. **Interest may cause a profit to be shown when no sales have been made.**
8. **Inclusion of interest in cost tends unduly to increase prices.**
9. **Interest is not a deciding or even an important factor in making cost comparisons.**

In evaluating the arguments for and against the inclusion of interest on investment as part of manufacturing overhead, Neuner (Cost Accounting: Principles and Practice) offers the suggestion that the items to be included in or excluded from cost depend entirely upon the purpose for which the cost figure is to be used. He states, "There is no such thing as a correct cost figure for all purposes." Schlatter and Schlatter (Cost Accounting) add to this by stating, "If the primary purpose of cost accounting is to afford better control over costs, and not merely to afford a means of evaluating inventories, the inclusion of interest may be highly desirable." They conclude by saying they favor the inclusion of interest ". . . in those cases in which management would be aided."

Determination of Interest Rate. Assuming that interest is to be included in manufacturing overhead, the determination of the rate is not easy. There are some differences of opinion as to what the rate represents. Neuner (Cost Accounting: Principles and Practice) refers to the rate of interest as an economic concept ". . . defined as the income derived from capital with a minimum of risk involved in the investment." Thus, the rate is the opportunity income foregone by not investing the capital in a risk-free investment. If this rate is used, then net profits as measured by the accountant would correspond more closely to the economist's concept of net profits which, in this regard, is the return demanded as a reward for risking the loss of capital.

If the cost figure is to be used in the **decision-making process** rather than in inventory valuation, the determination of the interest rate as described here may be unsatisfactory. Decision making is a process of choosing among competing alternatives, and one of the principal criteria for making such a choice is the relative profit of the alternatives. If **capital** must be devoted to the various projects, the **interest cost** becomes an important factor. The rate to be used in evaluating any specific project should be the income foregone by not investing in some other comparable project. Hence the rate of interest to be used is the income that could be earned in another project with a risk equal to the project being evaluated. Consequently the idea of a minimum risk-free rate of return is not necessarily applicable in decision making.

Many other problems arise in the determination of the rate. If the desired rate is to reflect the rate of return with a minimum amount of risk involved, does it make any difference whether the assets of the firm are in a form required to make such an investment? If a substantial part of the assets are in the form of fixed plant and equipment, an investment in government bonds, for example, is unrealistic. If, on the other hand, the rate is to be a measure of opportunity income in projects of equal risk, how can projects be compared if the risks are not equal? In the decision-making process, such a comparison is necessary because the problem eventually becomes one of choosing between different classes of projects rather than different projects within the same class.

Determination of Investment. Once the rate has been determined, the investment must be established. This is not an easy question to settle as Neuner (Cost Accounting) points out:

> For some, investment has been defined as the value of inventories plus the value of fixed assets after allowance for depreciation; for others, the investment is taken

as the sum of all assets except intangibles and investment in securities; for others, it may be any variation of these values.

In determining the amount of interest to be included in production cost, the investment necessary to carry on production should be used. As a practical matter, the **book value of the investment in net fixed assets** is probably the most common measure of investment. The investment in working capital, however, is also a necessary part of the productive facilities and hence should also be included.

Another problem in determining the amount of the investment is the date on which the investment is to be measured. Vance (Theory and Technique of Cost Accounting) indicates ". . . the average investment in each department" should be used. This is probably an average investment throughout a certain time period, perhaps a year. The investment in productive facilities at the end of the year represents assets which have been used during all or part of the year. The length of time the investment was used could differ, depending on the additional investment and the withdrawals during the year. Hence the **average investment** should be computed by weighing the additional investment and withdrawals against time differences.

The problem of including interest is further complicated where more than one type of product is involved. If the production process is not the same for all products, the investment should be determined by department, and a different amount assigned to each product, depending on the production process of each product.

Income Tax Adjustment. Even though interest may be included in the manufacturing overhead cost either for decision making or inventory valuation, such an imputed charge is not deductible for income tax purposes. Consequently an income tax adjustment is necessary if interest is included in computing net income. The fact that such a cost is not tax deductible is relatively unimportant, however, if some useful purpose will be served by including it. When interest is used as a measure of opportunity cost in decision making, inclusion is necessary in spite of the income tax regulations.

The effect of the **income tax regulations** on the determination of the interest rate presents another problem. Even though the rate of return in an alternative investment may be lower because of the income tax rate, it is possible to keep the entire analysis in terms of income before taxes. This is especially true of decision-making problems. To the extent that the income tax is a tax on net income and not on cost, this type of analysis will show the same results as that in which the rate of return is adjusted to allow for the tax.

In **inventory valuation** and **income determination**, the rate of interest should be adjusted to allow for income tax. In this case the measure of the rate is the income possible in a risk-free type of investment. The net income figure is then the return for risking the capital investment. Since the income tax is a tax on both types of income, the rate should be adjusted to show this fact.

Lang–McFarland–Schiff (Cost Accounting) conclude that if imputed interest "is to be shown at all, it should be treated as a partial distribution of net profits rather than as a charge to cost of production. This would involve an analysis of net profit into its component elements in order to reveal to management the relative earning capacity of the business."

Compromise Solution. One of the strongest arguments against the inclusion of imputed interest in cost is that it inflates the inventories and anticipates profit.

This inflation of profits is limited to the excess of the interest in the ending inventories over the interest in the beginning inventories. In periods where the amount of interest in beginning inventories exceeds that in ending inventories, the profit for the period will be less than if the interest had not been included at all. Although the two different methods of computing profit (imputed interest included and imputed interest excluded) show different profits for short periods because of the effect of carrying interest on the beginning and ending inventories, the profits over the entire life of the company will be the same by both methods.

Some accountants have worked out a compromise procedure so that the benefits of interest inclusion can be obtained while at the same time the inflation of inventories and profits is avoided. As explained by Schlatter and Schlatter (Cost Accounting), this method closes to the period's Profit and Loss account from the imputed interest income account an amount equal to the interest in the cost of goods sold plus the imputed interest in the unabsorbed burden balances which are being charged to Profit and Loss. Thus the debits and credits to Profit and Loss for imputed interest are equal and the net effect on income is zero. The balance remaining in the imputed interest income account is shown on the balance sheet as a deduction from inventories, and thus offsets the interest included in the inventories.

Imputed Rental on Owned Buildings and Equipment. This is sometimes suggested as an alternative to charging interest on investment, but it is only a partial solution because the investment used to determine the rental charge is limited to the fixed plant and facilities. Also, the rate which results from the use of a rental charge may not be a good measure of the opportunity cost. Dewing (The Financial Policy of Corporations) says:

> It is clear that in the vast majority of cases, rentals for the use of tangible property are in all respects identical with interest payments except in the control or administration of hired property. A corporation may either buy a piece of land, giving in payment borrowed money for which thereafter it must pay interest, or . . . lease the same land for a term of years for which thereafter it must pay rental. From the point of view of the corporation's general income account, the choice between paying interest or rental is merely a question of business expediency.

An extension of the foregoing reasoning has led some accountants to advocate imputed rental on equipment and buildings; this idea is closely related to interest on investment. Devine (Cost Accounting and Analysis) points out that "Accountants in the construction industry usually charge job cost sheets with rental rates and credit an account with equipment service income." **Equipment costs** which are included in the rental charge, such as depreciation, are summarized and compared with the **service income account.** The net effect of this procedure is to offset the increase in the job costs by an income from equipment service. The income from equipment service corresponds to the interest income account used if interest is imputed. The difference between the imputed rental and the actual building and equipment costs is the interest cost which the lessor would ordinarily have to pay.

DEPRECIATION ON REPLACEMENT COST. The replacement or reproduction cost of the fixed plant and equipment may be higher or lower than the original cost. This may be true for several reasons. One common cause of high replacement costs is the increase in the price level which causes a decrease in the purchasing power of the dollar. However, the replacement cost of equipment can vary in amount even though the price level remains constant.

Whatever the cause of the disparity between **original cost** and **replacement cost,** the problem arises as to what should be done, especially if the replacement cost is higher. Then the charge against profit for depreciation is not great enough to allow for future replacement of capital facilities and it is claimed that current profits are therefore overstated. Some accountants and many businessmen argue that this situation should be met by charging higher depreciation against current income. If this is done, the manufacturing overhead account reflects depreciation on the replacement cost rather than on the original cost of the fixed assets. If depreciation on replacement cost is higher or lower than depreciation on original cost, the ending inventories and the profit figure may be different, depending on the method chosen. If it is considered improper to charge production with replacement cost depreciation, an adjustment can be made. Such an adjustment reduces the inventories and adjusts the net profit back to the original cost basis.

Few, if any, problems in the realm of accounting aroused as much controversy in the 1940's and 1950's as the question of whether depreciation should be computed on the basis of **original cost,** or on original cost adjusted to present price levels, or on some other type of replacement cost. Economists, businessmen, labor leaders and others have contributed to the large volume of literature on this subject, in addition to accountants. For a discussion of this problem, see the Accountants' Handbook (Wixon, ed.).

RESEARCH AND DEVELOPMENT COSTS. Research and development costs are probably one of the most controversial elements of manufacturing overhead cost. NAA Research Series No. 10 (NAA Bulletin, vol. 28) reports that much of the controversy arises not so much from ". . . disagreement among accountants regarding the principles involved as from a lack of any general agreement as to the purposes for which such expenditures are incurred." In a later research study, Research Series No. 29 (NAA Bulletin, vol. 36), the objectives of such costs are listed as:

1. To maintain the company's present competitive position and profits by keeping existing products competitive in quality and price.
2. To improve the company's competitive position and to increase profits by developing new products which replace or supplement present products and by improving present products to the point where they have greater acceptability in the market than competitive products.
3. To explore possibilities for expansion into related or unrelated new fields which offer opportunity for substantial profits.

This study points out further that the variety of purposes served by research and development raises some difficult accounting problems. Even though a large portion of these costs results in future benefit to the firm, it is difficult to assign such costs to product. This difficulty arises because of the uncertainty of the outcome of some expenditures and because there may be a significant lag between the incurrence of the cost and the realization of the benefits.

If the expenditure for research and development results in a patent which is clearly of future benefit to the firm and is therefore recorded as an asset, the resulting **patent amortization** should be charged periodically to manufacturing overhead as a product cost. If, however, such expenditures are made to maintain the company's present competitive position (with no future benefit resulting), the amount should be charged directly to manufacturing overhead because this expenditure is part of the current cost of producing the product. Still another group of research costs could result which should be capitalized and should be

charged to profit and loss through operating expenses rather than through cost of goods sold. Such expenditures would result from objective number (3) listed above.

Company Practices. NAA Research Series No. 29, previously mentioned, is a survey of the practices of 35 companies. This study reports that, with a few partial exceptions, all companies participating in the study follow the practice of charging research and development costs as **charges against income** of the period in which the costs were incurred. A summary of the reasons for this treatment is as follows:

1. In most companies, research is a continuing operation, and the cost involved is viewed as similar to general and administrative expenses.
2. Benefits are difficult to measure and cannot be assigned to any specific period.
3. The success or failure of such expenditures may not be determined for several years.
4. The useful life of the knowledge gained from research and development activities cannot be predicted with sufficient accuracy to serve as a basis for cost amortization.
5. The practice of expensing such costs does not match costs and income from individual projects, but these errors tend to cancel out where research within a company is a continuous project.

SUPPLEMENTARY LABOR COSTS. In recent years, supplementary labor costs, commonly referred to as **fringe benefits,** have increased in amount. It is usually agreed that a portion of the supplementary labor cost is applicable to both direct and indirect labor (manufacturing overhead), but the treatment accorded these costs in the accounting records is not definitely settled. It is possible to treat all labor costs, except the basic wage payment to direct labor, as manufacturing overhead. All other supplementary production labor costs are charged to the manufacturing overhead account and are applied to jobs or products on the same basis as the other overhead items. Another possibility is to determine a supplementary labor rate and to charge the direct labor to jobs on the basis of the wage plus this supplementary rate.

Some of the supplementary labor costs involved in the controversy are:

1. Holiday pay.
2. Vacation pay.
3. Social security and unemployment taxes.
4. Overtime pay.
5. Paid lunch periods.
6. Union activities.
7. Bonus payments for night shifts.
8. Social activities.

As can be seen from this list, these costs are applicable to direct and indirect labor alike. The question is whether to try to apportion them or to treat them all as manufacturing overhead. (For a detailed discussion see section on Labor Costs.)

TAXES. The treatment of taxes as accounting costs involves no particular controversy as long as the problem is restricted to property or payroll taxes. **Property taxes** are usually allocated between manufacturing overhead cost, and selling and administrative expenses, depending on whether the facility being taxed is primarily devoted to manufacturing or selling. There may be some divergence of opinion as to how the allocation should be made, but most authorities agree that property taxes are correctly accounted for as a cost. The allocation of real

and personal property taxes is discussed in detail in the section on Distribution of Manufacturing Overhead. An explanation of the handling of **payroll taxes** is included in the section on Labor Costs.

When the business firm pays a **sales** or a **processing tax** as part of the purchase price of some commodity or service, this tax is usually included as part of the cost of that commodity or service. Such a tax may be stated separately from the purchase price as quoted by the selling firm, and actually the selling firm may be acting as a collection agency for the government. Nevertheless the presence of the tax increases the purchase price to the buying firm, and this increase is probably best treated as an element of cost.

In regard to the inclusion of **income taxes** as an element of manufacturing cost, Neuner (Cost Accounting) writes:

> . . in recent years, because of the high rates, a controversy has been started about the advisability of including state and federal income taxes in the cost of production. Some writers in the N.A.A. Bulletin and in a study made by the National Industrial Conference Board have recommended its inclusion as an element of cost. But the adoption of this idea has not as yet had very wide acceptance.

Keller (Management Accounting for Profit and Control) states: "It is generally accepted that taxes on income are a cost. True, they are a cost which is incurred only if a profit is realized, but if the objective of business is to earn the optimum profit and if this objective is achieved, the income tax cost will be incurred."

The Committee on Accounting Procedures of the AICPA made the following statement in Accounting Research Bulletin No. 23, and stated it again in ARB No. 43 (Restatement and Revision of Accounting Research Bulletins): "Income taxes are an expense that should be allocated, when necessary and practicable, to income and other accounts, as other expenses are allocated."

It may be inferred from this that part of the income tax charge should properly be included in the manufacturing overhead cost and charged to the unit of product. Lang–McFarland–Schiff (Cost Accounting) indicate that most companies account in the profit and loss statement for income taxes as a deduction from net profit. This treatment recognizes income taxes as a distribution of net income rather than as a manufacturing cost or an expense.

Manufacturing Overhead Classifications

USES OF MANUFACTURING OVERHEAD COST DATA. Since there are many different classifications of cost as well as methods of cost accumulation, it is necessary to establish some criteria in order to choose the best cost system for any given situation. The use to be made of the cost information is the most important basis on which to choose among different cost systems and classifications. This idea is stated in NAA Research Series No. 7 (NAA Bulletin, vol. 27) as follows:

> Costs are used for a variety of purposes, and the same cost data cannot serve all purposes equally well.
>
> Only by clearly describing and relating the various purposes for which costs are to be used is it possible to determine the types of cost data needed for each purpose and the principles and techniques which should govern their development.

The **uses of cost data** can be classified as follows:

1. Inventory costing and income determination.
2. Control of operations.
3. Managerial decision making.

It is not uncommon to find the foregoing classifications stated somewhat differently. NAA Research Series No. 7 lists **budgetary planning and pricing policy** in addition to the preceding three classifications. Budgetary planning can be thought of as a type of cost control, however, and the price policy of the firm is another type of decision-making problem.

INVENTORY COSTING AND INCOME DETERMINATION. The process of measuring periodic income requires the matching of costs and revenue on some consistent basis. If the **accrual method** is used, it is necessary that the production cost for the period be allocated to units of product so that the total costs can be assigned to cost of goods sold and to the ending inventories. Consequently, inventory costing is an important prerequisite for income determination.

Object or Unit of Costing. Since the process of income determination requires that a cost be assigned to ending inventories, it is necessary that the **cost per unit of output** be computed. For this purpose, then, the product is the object or unit of costing. The general theory underlying the assignment of cost to products is that the job or unit should be assigned those costs for which it is responsible. This principle can be applied more easily in accounting for direct production costs than in accounting for manufacturing overhead because manufacturing overhead represents a wide variety of different costs which are common to several units of product. This group of common costs is generally assigned to units of product on the basis of the **benefit** which the unit of output is thought to receive from the incurrence of the cost.

Since the objective in inventory costing is to determine a unit cost, the methods chosen for allocating overhead cost to the unit of product are important determinants of how overhead costs should be classified and accumulated. In general, costs may be classified according to:

1. Their assignability to the unit of product, i.e., direct or indirect costs
2. The department responsible for their incurrence, i.e., departmental costs.
3. The manner in which they react to volume changes, i.e., fixed and variable costs.

All these classifications are important in computing the unit cost for inventory costing.

Direct and Indirect Costs. This division attempts to classify costs on the basis of their assignability to the unit of product. Direct costs are those which can be identified directly with the unit of product. Actually, the **unit of costing** determines whether a cost is direct or indirect; as the unit of costing changes, some indirect costs may be converted to direct costs. For example, the salary of the departmental foreman is an indirect unit cost if several different units are processed within the one department; if the unit of costing is the department, the salary of the foreman becomes a direct cost. For **inventory costing**, however, the object of costing is the unit of product.

Indirect costs include those costs which are common to several units of product as well as some unimportant costs which are too small to justify tracing them to the unit. These costs are commonly referred to as manufacturing overhead. Once the indirect costs have been determined, it is then necessary to find a means of allocating the total cost to the units of production.

Classification of costs on the basis of **assignability to specific units of product**, although necessary for inventory costing, can become very involved as the number of different units produced is increased. It may be necessary in a

company having numerous different products to classify costs as direct and indirect according to **product lines** rather than to individual products. Eberhart (NAA Bulletin, vol. 38) expresses this idea as follows:

> . . . The classification procedure, a good tool in the early stages, can become burdensome in a company having numerous lines of product which, with the passage of time, have become diversified into several hundred different sizes and designs In such an instance, the principle of classification still holds good, but its application must be directed, not to multiplying classifications but to developing composite classifications or product groups under which the complexity of control may be minimized for management.

It may be that certain manufacturing overhead costs can be assigned directly to units of product if certain measurement techniques are used. If this is done, only part of the overhead can be assigned on the basis of a **predetermined average rate**, and the procedure will affect the method of accumulating the overhead cost. For example, purchased electric power may be assigned to specific jobs on the basis of the metered kilowatt-hours reported. The credit for the application of this cost into process should not be made to the Manufacturing Overhead Control account but rather to a Purchased Power account. The actual cost of purchased power would not be used to determine the under- or overapplied manufacturing overhead. The firm would, in fact, be faced with a disposition of two separate variances—a general manufacturing overhead variance and a purchased power variance. The cost of the purchased power would have to be accumulated in a separate account so that the proper distribution rate could be computed.

Just as some indirect costs may be assigned to product on a direct basis, it is also possible that some direct costs may be assigned to product as a part of the indirect or manufacturing overhead costs. For example, if during a given period the spoilage in direct raw materials has been abnormal, it may be argued that the element of **abnormal spoilage** should be charged to overhead. Such a procedure would charge all jobs with a portion of the spoilage instead of charging specific jobs on a direct basis. This procedure could also be followed for overtime premium and supplementary labor costs. The primary justification for this procedure is the benefit principle mentioned under Object or Unit of Costing in this section. It may be argued that the specific job during which the spoilage or overtime occurred is not the only job to benefit from such a cost; instead, the cost is of benefit to all work done during the period. Whichever procedure is followed, the mechanics of overhead accumulation are affected.

Departmentalization of Cost. Sometimes a simple classification of costs on a direct or indirect product basis is insufficient for inventory costing. These situations arise where the firm produces more than one product and the production processes of all products are not the same. If manufacturing overhead is collected on a plant-wide basis, the assignment of this cost is made by using a **plant-wide overhead rate.** If there were differences in the production processes, such a rate might not give a good measure of the cost benefit received by each product. When this situation exists, the common solution is to assign overhead to product by using **departmental overhead rates** rather than plant-wide overhead rates. If this method is used, the method of accumulating overhead cost must be altered.

Matz–Curry–Frank (Cost Accounting) give the following reasons for departmental overhead cost accounting:

1. To control overhead cost more adequately.
2. To secure more accurate costing of jobs and products.

To explain further what they mean by accurate costing of jobs and products, the authors state that departmental accounting for overhead leads to the application of overhead on the basis of departmental overhead rates rather than plant-wide rates. By using departmental overhead rates, a job is charged with costs incurred in departments through which it is processed. Consequently a job which is primarily an assembly project would not be charged overhead at the same rate as a job which spends much time in a department which has high overhead costs rather than high labor costs. Hence the benefit received by a job as a result of overhead cost incurrence is more accurately traced.

Even though departmental overhead rates require that costs be collected by departments rather than by object of expenditure only, the classification of costs within each department can be in terms of the assignability of the cost to the product. Hence a departmental classification is superimposed on the direct and indirect classification; i.e., it is still necessary to separate the payroll into direct and indirect labor, but instead of one account for each type of cost there is one account for each type of cost within each department.

In the development of manufacturing departmental overhead rates, it may be necessary to account for certain **service costs.** An example is the labor cost expended in the production of electric power. Since this cost is common to all manufacturing departments, the assignment is made to a service department first, and then it is allocated to the manufacturing departments on the basis of a **service department cost rate.**

Volume Considerations in Direct Costing. The predetermined rate used to assign overhead to product is usually determined on the basis of an overhead estimate or budget. This is true whether the rate is plant-wide or departmental. If some of the manufacturing overhead is fixed in relation to volume changes, the firm faces some serious problems created by a **fluctuating volume of production.** Since the fixed cost per unit varies inversely with the number of units over which the fixed cost is assigned, it is necessary to specify a certain volume in order to determine the fixed cost per unit. If the actual volume is more or less than the volume specified in the determination of the rate, the fixed overhead costs will be either under- or overabsorbed and a **volume variance** will result.

To develop the overhead budget and the overhead rate, information on both fixed and variable overhead is needed. Overhead must then be classified into fixed and variable cost components. Since the budget may be prepared on a departmental basis, a departmental classification should be superimposed on the fixed and variable cost classifications. This procedure will allow for the preparation of a **flexible budget** and will enable the firm to divide any under- or overapplied overhead into the component variances caused by either volume or spending.

During the past several years, much emphasis has been placed on a costing technique known as **direct costing.** This is a method of costing where only variable manufacturing costs (including direct labor and direct material) are considered product costs and all fixed manufacturing costs are charged to the period. Under this costing plan, only the variable overhead costs are assigned to inventory and cost of goods sold, and all the fixed overhead costs are charged to the period.

The method of overhead accumulation is affected if direct costing is used in the assignment of overhead to production. To begin with, it is necessary to classify overhead into fixed and variable costs. For this reason it is necessary to have two accounts for any natural cost classification which has both a fixed and variable part. For example, if a certain indirect labor cost is semi-variable, it is

necessary to classify this overhead cost into that part of the indirect labor which is fixed and that part which is variable. Two accounts will be required with direct costing whereas only one is sufficient under full costing. If a manufacturing overhead control account is used to summarize the subsidiary information, two control accounts will be required instead of one if direct costing is used and is incorporated in the formal records. (For a detailed discussion of direct costing, see section on Manufacturing Overhead and Product Cost.)

CONTROL OF OPERATIONS. The control of business operations consists of securing compliance with and conformity to the general **plan of operation.** If the future plans of the firm are stated in terms of profit, the control of cost is important (see section on Cost Control, Budgets, and Reports). Hence another very important use of cost information is for control purposes.

Goetz (Advanced Management, vol. 12) describes the process as follows:

> Control consists of securing conformity to plans. Individual employees are the operational units by means of which managerial plans are brought to fruition. These individuals must be directed, motivated, inspected, and corrected. This involves establishment of standards in terms of individuals' responsibilities, communication of plans and standards to subordinates, compensation for performance, measurement of results in terms comparable with statement of plans and standards, and remedial action wherever performance is found deficient as compared to plans. The accounting problem concerns reclassification of plans and standards according to individual responsibilities, followed by accumulation of performance data classified and measured in comparable terms.

Object or Unit of Costing. In accounting for control purposes, the object or unit of costing is not necessarily the unit of product as is the case in inventory costing. As can be seen from the preceding statement by Goetz, the control system centers around the individual employee, whether he is a shop foreman, a supervisor, or even a factory manager. The objective of **cost control** is the performance of the same job at a lower cost or a better performance for the same cost. The only way to achieve this objective is to convince all the employees of its importance. Since they are responsible for the incurrence of costs, it follows that the supervisors and other employees alone are capable of controlling them.

In control accounting, then, the unit of costing becomes the **department** or **cost center.** At the head of each cost center is someone who is responsible for and has control over the incurrence of each cost assigned to that department.

Costing for control differs substantially from costing for inventory purposes. Therefore, in a control system the method of overhead accumulation is much different from the system designed for inventory costing. For example, in **inventory costing** (assuming direct costing is not used), the cost of a factory manager's office force would ultimately be assigned to the producing departments and then to the product processed by the producing departments. In control accounting, the cost center would be established for the factory manager's office cost and there would be no need to allocate this cost further. The producing department supervisors are not in a position to control this cost; hence, it should not be assigned to them. NAA Research Series No. 7 (NAA Bulletin, vol. 27) expresses this idea as follows: "Cost control differs from costing for profit determination in that cost control is concerned with the charge at the point of origin, while profit determination is concerned with its disposition. Effective control of costs requires their classification in terms of the individuals responsible for their incurrence."

Since the object of costing for cost control is the department or cost center, it is necessary that the overhead records be kept on a departmental basis. This expands the number of overhead accounts. For example, one overhead account is insufficient for indirect materials and supplies, since with departmentalization it is necessary to have such an account for each cost center using indirect materials and supplies. If only one account were used, the variance reported would be due to the actions of several departments and individuals, and the cause of the variance would be very difficult if not impossible to determine. Simpsen (NAA Bulletin, vol. 35) expresses the need for departmental accounting as follows:

> The normal procedure, in the absence of departmentalization (to assume the extreme case), is to prepare detailed analyses of the accounts which seem to be particularly out of line. The cost accountant prepares such schedules, showing each item charged during the month to each expense account analyzed. The plant manager must then try to use this information to do something about controlling current costs of factory operation. The plant manager is in the position of having an excess of detail. The analysis obviously contains matter both relevant and irrelevant to excessive spending. He knows very definitely that there is something wrong in his cost picture but cannot quite "pin it down." He is like a reader who asks for a book on budgetary control and is given a dictionary. The dictionary includes all the words but they are not in the right order for his purposes.

Controllable and Noncontrollable Costs. The first step under a system for overhead cost control is to establish the departments or cost centers. The second step is to appoint some individual within the cost center to be responsible for the incurrence of the costs assigned. The **cost report** and the **cost accounts** are then set up to report to this individual. Next the total overhead should be classified on the basis of controllable and noncontrollable cost in relation to the various cost centers. If a cost is controllable by a particular cost center, it should be collected within the cost accounts of this cost center and reported to the individual responsible for the cost center operations.

Some controversy exists among accountants as to which cost classification is best to determine the **controllable costs.** One possible classification of manufacturing overhead would be a direct and indirect departmental classification. The controllable costs are those which can be traced directly to the cost center. Some overhead costs which are indirect when the product is the object of costing may become direct departmental expenses. In general, such direct costs should be reported on the department's cost report, but no attempt need be made to allocate the indirect overhead costs.

In tracing overhead costs to cost centers, it may be that no one cost center has complete control over certain direct costs. In such a case it is necessary to account for these costs so that only the controllable element of the cost is reported. Assume that the operations of the period required indirect materials and supplies in the amount of $5,000, and the firm purchased $6,000 of the same type of materials and supplies during the period. The accounts shown in Fig. 1 are typical if a plant-wide overhead rate is used for product costing.

As can be seen from Fig. 1, the accounting for overhead in product costing need not be elaborate if a plant-wide overhead rate is used. For control purposes, however, a more detailed accounting is needed. To begin with, the **indirect materials and supplies** cost must be separated according to the amount used by each department. This can be done by having the stores clerk summarize the requisitions at the end of the period, or by posting the requisitions so the information can be included in the formal cost records. The requisitioning from stores must be done on a departmental basis if this system is to work properly.

Vouchers Payable

	$6,000 (1)

Indirect Materials and Supplies —Stores

(1) $6,000	Various credits totaling $5,000 (2)
Balance $1,000	

Indirect Materials and Supplies Used—All Departments

(2) Various debits totaling $5,000	$5,000 (3)

Manufacturing Overhead Control

(3) $5,000	Credits made to control account on the basis of plant-wide rate for all overhead costs

(1) To record the purchase of indirect materials and supplies.
(2) To record the various issuances during the period.
(3) To close the subsidiary cost account to the control account.

Fig. 1. Ledger accounts used for indirect materials and supplies.

Even though the cost of materials and supplies used can be traced directly to the using departments, the entire amount of the direct cost is not necessarily controllable by those departmental supervisors. In the case of indirect materials and supplies, the using department probably has no control over the price paid for these supplies even though the use or quantity element of the cost is controllable. Consequently it may be necessary to account for the cost in such a way that only the controllable factor—the quantity used by the department—is reported. If the price is to be controlled, a separate cost report must be issued to the individual responsible for the purchasing and pricing of the materials and supplies.

Standard Costs. If both price and quantity of materials and supplies are to be controlled, some kind of a standard price and a standard rate of usage is necessary. Furthermore the quantity purchased should be reported for the control of price, and the amount used should be reported in the control of the rate of usage.

The essence of control is comparison; consequently a **standard cost** is a good control technique. Such a cost may or may not be incorporated in the formal accounts; if it is not, sufficient detail must be collected so that variances can at least be reported. However, a standard cost is not the only possible criterion of measurement which can be used as a basis for comparison. It is possible to collect overhead cost information without using a standard cost and to compare the results of the current period with the results of the preceding period. This procedure has some shortcomings to the extent that differences such as volume exist between periods. It may nevertheless serve as a starting point in establishing a control system. Regardless of the criteria of measurement selected, there must be a substantial amount of cost detail collected; and the controllable element in a given cost must be separated from the noncontrollable element in reporting on a departmental basis. (For further discussion, see section on Analysis and Control of Standard Cost Variances.)

Volume Considerations in Control. Volume is an important consideration in the control of manufacturing overhead costs. In order to compare the actual results attained with some criteria of measurement, the volume differences between the actual and expected results must be corrected. To establish standards for comparison at different levels of volume and to report the actual results at a given level of volume, the accumulation of overhead must be in terms of the relationship of the cost to the **rate of output.** Hence the departmental or controllable costs must be further classified into fixed and variable components.

Flexible budgeting, as opposed to **fixed budgeting,** is a control technique which allows for differences in volume from period to period (see section on Cost Control, Budgets, and Reports). Matz–Curry–Frank (Cost Accounting) state:

> "Fixed" merely denotes the fact that the budget is not adjusted to actual volume attained. It represents a point fixed in advance with which actual results are compared. Budgets are based on certain definite assumed conditions and results. However, such an ideal situation exists in but a few cases. If conditions change radically, causing wide fluctuations, the results obtained by comparing actual results with a fixed budget cannot be expected to be very reliable.

The alternative to a fixed budget is a budget which stresses **cost and volume relationships,** so that when the actual results have been recorded, there exists a criterion of measurement at the same volume. In control accounting, the important variances are those caused by waste, inefficiency, and excessive spending and not variances caused by the fact that the standard was set on a volume which was not attained. Given the level of activity or volume for the period, the question is: Was the operation efficient cost-wise?

Some accountants use another justification for the fixed and variable cost classifications in control accounting. Vance (Theory and Technique of Cost Accounting) says: "Because the fixed costs cannot be readily changed, the terms 'controllable' and 'noncontrollable' are sometimes substituted for 'variable' and 'fixed' in these reports." This implies that fixed costs are not controllable; in many cases this is true, especially where the fixed costs result from the presence of fixed assets. However, the term "fixed" does not refer to the amount of the cost but to the relationship of the cost with volume. The amount of a fixed cost can change due to factors other than volume. If the firm wishes to control these other factors, then fixed costs can also be controllable. To think of fixed costs as being fixed in amount and therefore not controllable may lead to a policy of overlooking important areas of possible cost reduction.

If the volume element in costs is to be reflected through the formal cost records, departmental overhead should be classified into **fixed and variable costs.** This may not increase the number of accounts used unless one departmental cost has both fixed and variable components. In such a case two accounts may be used to report one cost, and the fixed and variable portions are collected separately. If this type of information is gathered, the preparation of the flexible budget for future periods is facilitated. This is true, at least to the extent that past information is the best guide to future expected costs. The variable element of the cost should be analyzed to determine its reaction to volume changes; projections for the future can then be made on this basis.

MANAGERIAL DECISION MAKING. Scitovsky (Welfare and Competition) points out that the firm or businessman faces three **basic decisions:**

1. How to produce.
2. How much to produce.
3. What combination of products to produce if it produces several products.

The first decision concerns the best combination of the factors of production and is made primarily on the basis of the relative costs of the factors of production. In the accountant's terminology, a replacement decision is a decision of how to produce. The second decision concerns the proper quantity of product to manufacture during any given period. Again, if profits are to be maximized, this decision is made on the basis of relative costs and revenues. The third decision is encountered in every firm in the sense that the businessman must choose the proper product to produce even if he has only one product, i.e., the decision maker must decide on the best possible use of the productive facility. If more than one product is being manufactured, the decision maker faces the more complex decision of what particular combination of products should be made and sold.

Cost is an important factor in each of these types of decision. (For further discussion of the problems of managerial decision making, see sections on Cost-Volume-Profit Relationships, Special Cost Analyses, and Cost Control, Budgets, and Reports.)

Cost Requirements for Decision Making. The whole function of management planning involves decision making. Goetz (Advanced Management, vol. 12) summarizes the planning process by stating: "Managerial planning includes formulation of policies, design of organization, selection of resources and establishment of techniques and procedures." Thus planning problems are in terms of alternative courses of future action. A **planning problem** arises when alternatives are present, for if there are no alternatives, then no decision needs to be made.

At this point, one of the most important differences between cost for decision making and cost for income reporting becomes apparent. Decision making is concerned primarily with future estimated cost, while income reporting and inventory costing are concerned with actual historical costs. The latter costs are not applicable to decision-making problems except insofar as they aid in projecting the future.

There is another very important difference between the cost requirements of decision making and inventory costing. Since decision making is a process of choosing among alternatives, the cost of taking one project may be the income foregone by not choosing another project. Consequently the costs pertinent for decision making are **opportunity costs** and in many cases must be imputed. In the conventional concept of income determination, there is no room for such costs. For example, if a firm is trying to decide whether to take an additional order (which is a once-and-for-all type of job), the question may arise as to the cost of raw materials to be used. In establishing the cost of the order, only the variable costs should be considered; the price quoted should normally be above the variable costs. Regardless of the inventory situation, however, the historical cost of the raw materials is not pertinent to this type of problem. If the raw materials are in inventory, the cost of using them to produce the order is either the salvage value or the replacement cost of the raw materials. If the materials are to be used but not be replaced, they should be costed at **net realizable value** (salvage value less cost of disposition). If the raw materials will be replaced for use in future work, the cost of producing the current order is the replacement cost of the materials at the time of replacement, discounted to the present. In neither case is the historical cost of the materials important, and yet this is the figure that is recorded in the formal records and is used for income reporting.

Variable and Fixed Costs. The classification of manufacturing overhead cost into variable and fixed components is necessary if the cost information is to be used in decision-making problems, since many of the decision-making questions are concerned with volume changes. A variable cost is one which changes in amount when volume changes while a fixed cost is not affected by volume changes. This does not mean that a fixed cost is fixed in amount, for there are other forces, such as price levels, market shortages, etc., which can cause fixed costs to change in amount from period to period. However, if a decision concerns the proper level of output, it is necessary to determine how the cost reacts to changes in volume while all other factors affecting costs are held constant.

Variable and fixed costs are difficult to determine because the costs are affected differently by different changes in volume. A cost which remains fixed if volume is changed by 5% may become partly variable if volume is changed by 15%. For example, certain **indirect labor costs,** such as repair and maintenance salaries, may remain the same if an additional order is taken on a once-and-for-all basis. If the increase in volume is considered to be permanent for an indefinite period, however, more repair and maintenance labor may have to be hired in some later period. Hence, whether a cost is variable or fixed depends on the decision to be made. In spite of this difficulty, there are some costs which are clearly fixed over wide ranges of output changes; and there are also variable costs of the same nature. For example, the cost of factory insurance may not change even if volume is changed by 50%; consequently it is a fixed cost for most decisions. On the other hand, the cost of **direct materials** used in manufacturing the product varies proportionately with the level of output.

Other Cost Classifications for Decision Making. Several writers have criticized the classification of cost into the simple dichotomy of variable and fixed. Browne and Titus (NAA Bulletin, vol. 33) point out that some fixed costs are not fixed in relation to volume but are simply fixed by managerial discretion. In an attempt to determine the variability in overhead in a given situation, these authors discovered that an important element of cost was made up of such items as travel expense, donations, and employee welfare. They point out that the only chance for variability in these expenses would be to discontinue, for example, the basketball or baseball programs or the sending of representatives to various conventions. They conclude that, "In short, managerial policy dictates that these costs are fixed under the hypothetical conditions we have assumed."

Wyer (NAA Bulletin, vol. 38) suggests the following groups of patterns of cost and volume relationships as being more meaningful and useful than the variable and fixed classifications:

1. Cost not related to volume in any recognizable way.
2. Cost related to amount of capacity provided.
3. Degree of variation has an easily recognized relationship with volume.
4. Relationship obscured by time lag, control basis, or accounting techniques.
5. Costs with uneven surge patterns.
6. Costs of inadequate capacity.

Goetz (Management Planning and Control) states:

For managerial planning and control, there is no single "right" hierarchy of classification of cost accounts. What management needs from cost accounting is a reliable, detailed, historical record of the facts of business operation, so classified and evaluated as to enable management or accountant to rearrange the data as required by each emergent managerial problem.

Recording Cost Data for Decisions. The rules suggested by Goetz (Management Planning and Control) for the initial recording of cost data to be used in decision-making problems may be summarized as follows:

1. **Do not merge nonhomogeneous items.** This rule calls for a separation of every item of cost having a different behavior pattern, following a different law of variation along any dimension. Goetz says that separate accounts should be kept for each cost factor instead of merging them all into one account. If this rule is followed in the basic record, appropriate subtotals can then be arrived at for each different managerial problem.
2. **Do not divide and prorate or allocate homogeneous elements.** Here Goetz specifies, by way of example, that overhead charges should not be chopped up and lost by allocations to departments, reallocations of service charges to manufacturing departments, and then further allocations to products. If no division is made in the basic or primary record, then any amount of subsequent allocations is possible to fit managerial needs and other needs as they arise.
3. **Do not merge income or expense items pertaining to different departments, processing centers or operations unless they originate as discrete quanta.** Such items of cost should be assigned to the smallest operating unit possible without making arbitrary allocations. Goetz points out that foremen's salaries, for example, can be assigned to departments but that they cannot be charged to operating centers and products without introducing arbitrary methods of allocation. If this rule is followed, operating programs differing in their operational or departmental content can be analyzed according to these differences.

FLEXIBILITY IN OVERHEAD COST CLASSIFICATION. The potential uses of overhead cost information are so great in number that a premium is placed on flexibility in record keeping. It may be that in a given situation the uses of this type of information are so diverse and great in number that many sets of records must be kept to serve the different purposes effectively.

In order to minimize the cost of record keeping, it is desirable to maintain as few sets of records as possible. By providing for as much flexibility as possible, by satisfying certain needs for information through special studies, and by making compromises in the needs for perfect cost data, several purposes can be served by a single set of basic records.

The starting point in developing a system of cost accumulation (overhead cost being no exception) is to specify the uses for the information. At the time the system is developed, certain uses cannot be anticipated, and some uses that are anticipated will not materialize. The need for revision in the cost system is ever present. If certain uses cannot be satisfied within the degree of accuracy desired, this fact should be recognized and even put in writing so that when such a need for information arises a special study can be conducted. The value of the information should be weighed against the cost of obtaining the information before the special study is begun.

Direct and Indirect Manufacturing Overhead

CLASSIFICATION BY NATURE OR OBJECT OF EXPENDITURE. For inventory costing, the most common cost classification of overhead is according to the assignability of the cost to the units of product. Such a classification is called a **direct or indirect cost classification.** If the unit of costing is the product, overhead costs are classified as indirect costs. If the unit of costing is the department, there are both direct and indirect departmental manufacturing overhead costs.

Within the direct and indirect cost classification, manufacturing overhead cost can be classified on either an **object of expenditure** basis or a **functional** basis. In many charts of accounts, both classifications are used. The object of expenditure classification indicates the purpose for which the cost was incurred, while the functional classification gives information on the uses of the particular costs. The functional classification is usually used in relation to the departmental activity. Examples of each type of classification are:

Object of Expenditure Classification of Manufacturing Overhead

1. Indirect materials and supplies.
2. Indirect labor.
3. Depreciation of buildings.
4. Depreciation of equipment.
5. Property taxes.
6. Insurance on factory buildings and equipment.
7. Light, heat, and water: factory.
8. Rent of factory.
9. Social Security taxes: employer's share.
10. Unemployment compensation insurance.

Functional Classification of Manufacturing Overhead

1. Indirect materials and supplies.
   a. Mechanical supplies.
   b. Coal and fuel oil.
   c. Lubricants.
   d. Office supplies.
   e. Garage supplies.
2. Indirect labor.
   a. Superintendents.
   b. Inspectors
   c. Cost clerks
   d. Truckers.
   e. Timekeepers
   f. Chauffeurs and garagemen.
   g. Storeskeepers and helpers.

Major Overhead Accounts. Manufacturing overhead accounts customarily are kept in a manufacturing or factory ledger with postings made on a monthly basis. These accounts, which are usually in an object of expenditure classification, are often referred to as **major overhead accounts,** in order to differentiate them from overhead costs classified on a functional basis. The major overhead accounts are the more important groupings of manufacturing overhead and are very similar to the primary manufacturing overhead accounts. A typical list of major overhead accounts is given by Lawrence (Cost Accounting, revised by Ruswinckel):

Indirect Cost Groups

100 Indirect Labor and Salaries
200 Operating Supplies
300 Expense Tools
400 Power, etc.
500 Maintenance, Replacement, Rearrangement
600 Employer Insurance, Taxes, etc.
700 Losses, Errors, and Defects
800 Fixed Charges
900 Miscellaneous

Notice that the first two groupings are equivalent to the indirect labor and indirect materials and supplies groupings in the primary manufacturing overhead classification, and the last seven groupings are similar to the "other factory costs" discussed in this section under Primary Manufacturing Overhead Costs.

Subsidiary Overhead Accounts. The major overhead accounts are usually subdivided in order to provide more detail on the nature of the cost. The subdivision may be on a departmental or functional basis, or it may be simply a more detailed listing of accounts. The following is a list of **subsidiary accounts** adapted from Lawrence (Cost Accounting, revised by Ruswinckel), which can be used to supplement the information given in the major overhead account classification shown before.

100 Indirect Labor and Salaries

110 Supervision
120 Clerical
130 Materials Handling
140 Building and Property Attendants
150 Machine Tool and Die Setting
160 Drafting and Engineering Unapplied
180 Inspection
190 Sundry Indirect Labor

200 Operating Supplies

210 Fuel
220 Lubricants and Cutting Compound
230 Mill Supplies
240 Stationery and Office Supplies
250 Testing Supplies
260 Packing and Shipping Supplies
270 Processing Supplies
280 Indirect Material
290 Sundry Operating Supplies

300 Expense Tools

310 Cutting Tools
320 Electric Tools
330 Hand Tools

400 Power

410 Electric Power
420 Electric Light
430 Heat
440 Air
450 Steam
460 Gas
470 Water
480 Sundry Utilities

500 Maintenance, Replacement, Rearrangement

510 Land Improvements
520 Buildings
530 Machinery and Equipment
540 Tool Maintenance and Repair
550 Drawings and Blueprints
560 Furniture and Fixtures
570 Plant Rearrangement

600 Employer Insurance, Taxes

610 Employee Group Insurance
620 Employee Hospitalization Insurance
630 Compensation Insurance
640 State Unemployment Compensation Tax
650 Federal Unemployment Compensation Tax
660 Federal Insurance Contribution Tax
670 Provision for Vacation Pay
680 Night Shift and Overtime Premium
690 Standby Time

700 Losses, Errors, and Defects

710 Defective Work Scrapped
720 Defective Material and Product Reworked
730 Unrecovered Cost of Sale of Seconds
740 Substituted Material
750 Lost and Found Material

800 Fixed Charges

810 Depreciation of Land Improvements
820 Depreciation of Buildings
830 Depreciation of Machinery and Equipment
840 Depreciation of Furniture
850 Gains or Loss on Fixed Asset Disposals
860 Insurance
870 Taxes
880 Rentals
890 Amortization of Leaseholds and Improvements

900 Miscellaneous

910 Traveling Expenses
920 Company Car Expense
930 Telephone and Telegraph
940 Factory Office Postage
950 Demurrage
960 Welfare and Recreation
970 Lost Time Paid to Absentees
980 Allowance for Temporary Military Leaves
990 Other Sundry

The above chart of accounts could be more detailed by subdividing the subsidiary accounts. Lawrence (Cost Accounting, revised by Ruswinckel) gives such a breakdown for **indirect labor and salaries,** which is listed in part as follows:

110 Supervision

111 Plant Superintendents
112 Departmental Managers
113 Foremen

120 Clerical

121 Clerks Under Management and Foremen
122 Factory Accounting Department Employees
123 Purchasing and Material Clerks
124 Office Service
125 Traffic Department

130 Materials Handling

131 Receiving Clerks
132 Raw Materials Warehouse Attendants
133 Supply Room Attendants
134 Truckers
135 Scrap and Salvage Handling

The mere classification of an account does not in itself solve anything. It is necessary to know the content of each account. A **manual of instructions** for each classification of accounts may be issued to ensure a uniform distribution of account charges. The following is an example of an **account description** which may appear in such a manual.

710 Defective Work Scrapped. This is subdivided as follows:

711 Defective Workmanship. This account is charged with losses due to defective workmanship; for example, operator's errors, carelessness, breakage, etc.
712 Defective Purchased Material. This account is charged with losses due to defective materials, either bought outside or received from another works or district.
713 Other Losses Due to Errors. This account is charged with losses due to errors of clerical employees; for example, replacement of lost material, materials ordered incorrectly, ordering or producing in excess of requirements, expense of cutting down stock materials to standard stock sizes when sufficient material is not available of the stock sizes required, expense of cutting down stock materials to special nonstock sizes when it is impossible to wait until the special size can be bought outside, loss on materials or apparatus damaged or lost in transportation between departments, etc.

Departmental Manufacturing Overhead

SELECTION OF DEPARTMENTS. A manufacturing plant is organized along departmental lines, primarily for production purposes, in order to:

1. Segregate basically different processes of production.
2. Secure the smoothest possible flow of production.
3. Establish lines of responsibility for physical control over production.

A cost accounting system is designed to fit into departmentalization from this physical plant viewpoint. This makes possible the accumulation of production costs on either a job or a process basis for operations carried on within each department. The purpose of such departmental cost accounting is either to establish departmental overhead rates, facilitate cost control, or both.

When choosing the **department cost centers,** many factors must be considered. Some of these factors are:

1. The division of responsibility for production and cost incurrence This information may appear in the factory organization chart.
2. The location of operations and processes.
3. The nature of the operations within each process with respect to the physical movement of products throughout the factory. This is especially important in the development of departmental overhead cost rates to be used in product costing.
4. The number of departments or cost centers. As the number of departments and cost centers increases, the amount of detail in the cost system increases. The cost of accumulating the information as well as the value of the information should be considered in establishing the number of cost centers.
5. The similarity of machinery, processes, or operations within each department or cost center.

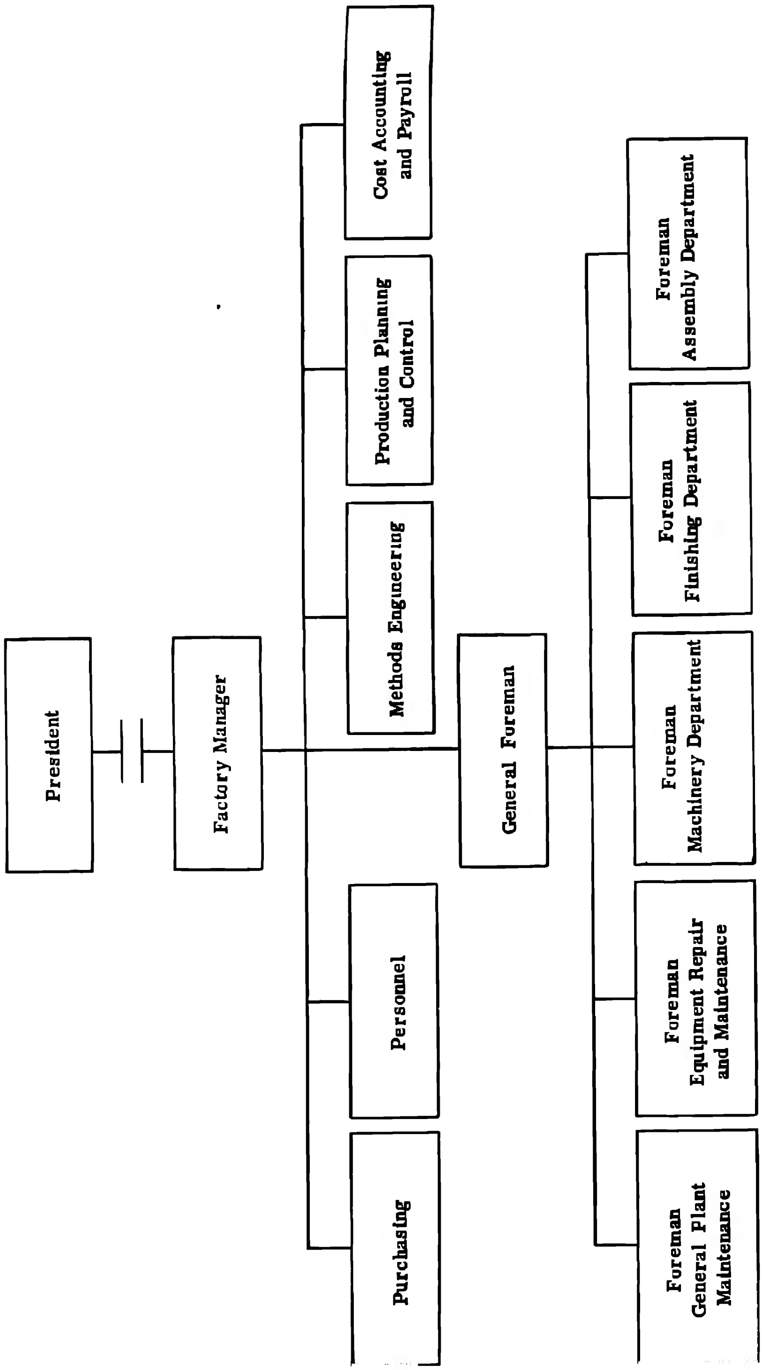


Fig. 2. Factory organization chart.

The selection of departments from the **plant organization chart** can be seen in Fig. 2. If the basic purpose of the departmental system is the control of costs, a department may be established for every foreman or manager from the factory manager downward. If the purpose of the departmental accounting system is the development of overhead rates, four departments may be used—general factory administration and service, and the three producing departments.

As can be seen from Fig. 2, the number of departments may differ, depending on the purpose of the cost system. Frequently the number of departments is greater for control purposes than for overhead rate determination. Sometimes it is feasible to adapt a control system to produce rate information by combining control departments into segments. This procedure has the advantage of reducing the number of overhead rates to be used in costing the product. At the same time the system may work very well for control purposes.

Arnold (NAA Bulletin, vol. 35) reports a departmental cost system which uses 74 separate departments for administration and control purposes. These 74 departments are grouped into **manufacturing burden centers** and **nonburden centers.** The overhead rates are developed in the manufacturing burden centers, where 50 departments are combined into 11 burden centers on the basis of similarity of departmental operation. As new operations are encountered, the number of burden centers is changed. The burden centers may contain one or several departments. A list of the centers and the number of departments within each burden center is as follows:

Burden Center	Number of Departments
1. Press	1
2. General Machine	6
3. Automatic Screw Machine	1
4. Lacquer	1
5. Buff and Plate	4
6. Assembly	17
7. Product Quality	5
8. Facilities and Service	5
9. Product Development and Design Engineering	1
10 Special Products, A	2
11. Special Products, B	7
	50

The nonburden centers are Building Service (made up of 2 departments), Manufacturing Service (made up of 5 departments), and General Staff (made up of 17 departments). The nonburden center costs are allocated to the burden center costs, and 11 rates are developed for use in product costing.

MANUFACTURING OR PRODUCING DEPARTMENTS. In general, a manufacturing department is one in which manual and machine operations are performed directly upon any part of the commodities produced. This may be also referred to as a **producing, production, or productive department.** More specifically, productive departments are those whose cost may be charged to the product because they have contributed directly to its production. Note that it is unnecessary for the product to actually pass through the department in order for it to be classified as productive. As an illustration, the core-making department of a foundry is considered a productive department, even though castings are not worked on in this department. The ability to charge core-making costs to individual jobs or classes of products justifies its classification as a productive department.

Variation by Industry. The names of manufacturing departments depend on the nature of the industry and the type of work performed. Departments commonly found in the industries named below are:

Plate glass factory: mixing, melting, polishing and grinding, uncut stock wareroom, order-cutting wareroom.
Cement mill: stone crushing, raw grinding and mixing, coal crushing and pulverizing, kiln burning and cooling, finish grinding and storing, and packing and unloading.
Machine-tool manufacturing concern: forging, annealing, heat treating, pattern making, core-making, molding, melting, chipping and cleaning, machine shop, assembly, fitting and erecting.
China manufacturing company: clay mixing, kiln, decorating, and packing and shipping.
Coal mine (departments comparable to manufacturing departments): mining, hoisting, crushing, screening, washing, and loading.

Subdividing Manufacturing Departments. In many cases, for cost application as well as for control purposes, direct manufacturing departments are subdivided. Such **subdivisions** are referred to as cost centers, although a cost center can also represent a recombination of departments. Where two or more different types of work are performed in the same department (under common supervision), such subdivisions may produce a better overhead application rate even though the department is a good unit for cost control.

The Outline of Petroleum-Industry Accounting (prepared by the Accounts and Accounting Procedures Subcommittee of the Financial and Accounting Committee, American Petroleum Institute) provides the following example of dividing producing departments into cost centers:

Producing Department	Cost Center
Cracking and Reforming	Catalytic Cracking
	Steam Cracking
	Thermal Cracking
Lubricating-Oil Manufacturing	De-asphalting
	Acid Testing
	Solvent Extraction
	Dewaxing
	Filtering
	Fractionation
	Compounding and Blending
Wax Manufacture	Refrigeration
	Pressing
	Sweating
	Filtering
	Distillation
Asphalt Manufacture	Asphalt Stripping
	Oxidizing
	Blending
Miscellaneous Manufacturing Operations	Desalting
	Coke Production

SERVICE DEPARTMENTS. Service departments are not directly engaged in production but do render particular types of service for the benefit of other departments. In some instances the services furnished benefit other service

departments as well as manufacturing departments. Note that commodities and jobs manufactured do not pass through service departments. The cost incurred in the operation of service departments, however, represents a part of the total manufacturing cost that eventually must be absorbed in product for purposes of inventory costing.

The costs which are collected in service departments might be reallocated to other service or manufacturing departments. For control purposes no reallocation may be necessary, but in inventory costing all production costs must ultimately be allocated to the unit of product. It is possible to charge the manufacturing or other using departments for services on a quantitative basis other than the dollar. If it is desirable to report in terms of dollars, the cost of producing the service should be localized in the service departments, and any allocation for the use of the service to using departments should preferably be made on the basis of a standard cost and not an actual cost.

Types of Service Departments. Names of service departments vary with the nature of the concern and the service rendered. Some service departments are common to practically all industrial firms, such as **storeroom service, factory cost accounting service,** and **timekeeping and payroll services.** Small plants may have only a few service departments; large firms may have many service departments.

Simpsen (NAA Bulletin, vol. 35) reports the following list of **staff and service departments** which, in one case, facilitated cost control. The departmental breakdown was made on a functional basis, and one foreman was in charge of each department listed.

Staff and Service Departments

750	General Factory	769	Purchasing
751	Production Control	770	Engineering
752	Production Engineering	772	Quality
753	Materials Handling	773	Salvage
754	Electrical Maintenance	776	Personnel
755	Housekeeping	782	Traffic
757	Mechanical Maintenance	783	Shipping
760	Experimental	790	Accounting
761	Tool Machine	799	General and Administrative
766	Tool Grinding		

Subdividing Service Departments. Service departments can be divided or recombined in various ways. Such a subdivision or recombination is referred to as a **cost center.** The actual structure of a departmental organization depends on the type of cost information needed, which in turn depends on the use of the data. As an example of different combinations, one **maintenance department** may have separate shops, such as (1) Blacksmith Repair, (2) Building Occupancy, (3) Carpenter Repair, (4) Electric Repair, and (5) Machine Repair. Another company may have, for accounting purposes, only one maintenance department.

Fig. 3 is typical of detailed **subclassifications of service departments.**

DEPARTMENTAL MANUFACTURING OVERHEAD COST ANALYSIS. A twofold analysis of all factory overhead costs, by object of expenditure and by department (manufacturing and service), is a desirable cost accounting procedure. The following objectives are thus attained:

1. It segregates factory overhead costs and provides a total for each service department, which is necessary before a service department cost distribution

Stores
- Purchasing
- Receiving
- Salvage
- Storage

Industrial Relations
- Employment
- Medical
- Fire
- Police
- Welfare
- Cafeteria

Power
- Boiler Plant
- Electrical Generation
- Electrical Transmission
- Compressed Air
- Hydraulic
- Gas

Laboratory and Development
- General Research
- Chemical Testing
- Fabric Testing
- Physical Testing
- Specifications
- Technical Service

Shop Departments
- Mold and Core
- Machine Shop
- Toolroom
- Drafting
- Electrical Maintenance

Clerical
- Timekeeping
- Payroll
- Cost
- Factory Accounting
- Time Study
- Production Planning
- Scheduling

Transportation and Service
- Garage
- Central Trucking
- General Yard

Finished Product
- Shipping
- Warehouse

Fig. 3. Typical subclassifications of service departments.

can be made to manufacturing departments. Such a distribution may be necessary in inventory costing.

2. It segregates manufacturing department costs applicable directly to the producing and service departments. This procedure is necessary because it forms a basis, along with objective (1), for determining overhead cost rates to be applied to product.
3. It makes possible the establishment of controls to keep costs at a minimum.

Classification by Object of Expenditure. Departmental overhead costs, classified by object of expenditure, may be collected or accumulated by:

1. Establishing separate accounts and records for each department and classifying costs by object of expenditure. Each department has an account for each overhead cost plus a control account for the department.
2. Collecting departmental cost information outside of the formal records. If this is done, only one account for factory overhead control appears in the factory ledger.

The collection of departmental cost information **outside of the formal ledger records** is the second method of accumulation. As overhead costs are incurred, the debit is made to the factory overhead control account. This entry is also posted in a subsidiary record which may take the form of a **standing order record** (Fig. 4). Such a record is kept for each department and the detail of the cost by object of expenditure appears on this record. At the end of the accounting period, the various overhead costs shown on the standing order form are totaled and a summary is made (Fig. 5). The overhead costs by department and

Assembly — Department | 60 – 102 — Account Number

Date	Explanation	Ref.	Total Cost	Labor	Materials and Supplies	Depreciation	Other
Dec. 1	Labor	V.R.	$15,000	$15,000	$	$	$
3	Supplies	V.R.	5,000		5,000		
7	Repair Materials	V.R.	500				500
10	Supplies	V.R.	4,000		4,000		
15	Labor	V.R.	6,000	6,000			
20	Supplies	V.R.	6,000		6,000		
31	Maintenance	V.R.	700				700
31	Depreciation	G. J.	3,000			3,000	
	Totals		$40,200	$21,000	$15,000	$3,000	$1,200

Fig. 4. Standing order form for subsidiary department cost record.

by object of expenditure are shown on this summary form. The total cost ($150,300 in Fig. 5) should agree with the total overhead in the Manufacturing Overhead Control account. The total cost is also broken down by department ($40,200 for the Assembly Department in Fig. 4). This departmental cost information can be used in developing departmental overhead rates or in reporting for cost control purposes.

December, 19____

Standing Order		Total Overhead	Labor	Materials and Supplies	Depreciation	Other
Dept.	Number					
Cutting	60-100	$ 50,100	$25,000	$15,100	$10,000	$
Finishing	60-101	60,000	30,000	25,500	4,000	500
Assembly	60-102	40,200	21,000	15,000	3,000	1,200
Totals		$150,300	$76,000	$55,600	$17,000	$1,700

Fig. 5. Summary of departmental overhead costs from standing orders.

CONTENT OF DEPARTMENTAL MANUFACTURING OVERHEAD ACCOUNTS. A few service departments and their account content are discussed in the subsequent paragraphs.

Factory Accounting and Payroll Departments. The factory accounting department performs functions with respect to cost transactions as follows:

1. Assembles original records containing cost data pertaining to raw materials, direct labor, and overhead costs.
2. Sorts these cost data.
3. Journalizes and posts cost data.
4. Analyzes cost data by cost elements, departments, operations, orders, products, and jobs.
5. Synthesizes cost data as called for by company executives.
6. Prepares cost reports.
7. Computes work in process inventory values.
8. Computes unit costs, finished goods inventory values, and costs of sales for commodities and jobs.

Costs of factory accounting include factory office supplies, stationery and printing, light, power, heat, maintenance and repairs of equipment, social security taxes, workmen's compensation insurance, tabulating machine rentals for tabulating equipment located in the cost department, depreciation and property insurance on company-owned equipment, depreciation and property taxes and insurance on building space occupied by the cost accounting department, and salaries of cost accountants and clerks.

The **payroll department** handles time tickets for all manufacturing and service departments and, in so doing, performs the following functions:

1. Records daily hours worked or daily earnings upon payroll.
2. Enters individual employees' rates on time tickets or payroll sheet.
3. Verifies accuracy of employees' daily earnings by application of internal control procedure.
4. Computes individual employees' deductions.
5. Calculates individual employees' earnings.
6. Prepares pay checks or pay envelopes.
7. Maintains individual employees' earnings and hours-worked records.
8. Pays employees.

The costs incurred in the payroll functions include office supplies and printed forms, electric current and heat, wages paid to employees and all supplementary payroll costs, depreciation and insurance on departmental equipment, and supervisory salaries. (See section on Labor Costs for further details on payroll functions.)

Toolroom Service Department. The toolroom in a typical industrial firm performs the following three functions:

1. Issues and checks the return of expensive hand tools which are kept in the custody of the toolroom when not in use.
2. Aids in carrying on development and research work.
3. Makes tools and dies for factory use and maintains such tools.

The costs incurred to carry on these functions include factory supplies, small tools, light, heat, power, compressed air, maintenance of equipment, wages plus supplemental labor costs, and depreciation, insurance, and taxes on equipment.

Power Service Department. The boiler room produces steam which is used for generating electric current, compressing air, heating buildings, air conditioning buildings, and for manufacturing purposes. Steam produced in boilers, in turn, is a cost to other subdivisions of power service and producing departments.

In the production of steam, costs incurred are boiler fuel, sundry supplies, small tools, water, air, power, light, equipment repairs and maintenance, wages, depreciation and liability insurance on equipment, and depreciation, insurance, and

property taxes on the building that houses the boiler room equipment. In the generation of electric current, costs included are steam, gas, air, heat, water, power, light, small tools, maintenance and repairs on the equipment, and wages. In the compression of air, the transferring of hot water or steam to buildings for heating purposes, and the providing of air conditioning, the costs are similar to those for steam.

Variable and Fixed Manufacturing Overhead

CLASSIFICATION OF OVERHEAD ACCORDING TO VARIABILITY. There are many factors which influence the amount of overhead cost, one of the most important being changes in volume. A classification of cost according to changes in volume attempts to establish the cost behavior with respect to the degree of variability. This type of classification is possible only when specific assumptions are made regarding the plant facility to be employed, prices, managerial policies regarding maintenance of an organization, and the state of technology. The cost classification arrived at is a static function and is valid for only a specific purpose and a limited period of time. As the underlying conditions change, the classification must be revised.

In seeking a relationship between cost and volume, serious consideration must be given to the selection of the unit used to measure volume. Using the unit of product to measure volume may be a completely unsound approach, especially where the firm sells many different products. If **sales value of production** is used, certain problems arise when the selling prices change. The following statement briefly summarizes the four factors which NAA Research Series No. 16 (NAA Bulletin, vol. 30) indicates must be considered.

1. The unit must measure fluctuations in the activity which causes the cost to vary. It is necessary to study each department to discover a unit of volume which measures the cost-incurring activity within the department. Vatter (The Journal of Business, vol. 43) adds to this statement by saying, "The measure of the rate of activity should be some physical factor that reflects clearly the services provided by the department or operation; it should not be affected by variations in the uses to which these services may be applied."
2. The unit chosen should be affected as little as possible by variable factors other than volume. When sales are used to measure volume, a change in the sales price which is not accompanied by a like change in variable cost distorts the relationship between sales and cost. Under such conditions, the sales volume can vary with physical volume and variable costs remain unchanged.
3. The unit should be one which is simple and easily understood. Weighted activity indexes used in place of sales, labor dollars, or labor hours may be difficult for the user of the information to understand.
4. The activity figures should be obtainable without undue additional clerical expense.

When measuring cost and volume changes within a plant, several different measures of volume may be used, depending on the nature of the department. An over-all measure of volume may be necessary, however, in order to reflect the relationship between total **cost-profit-volume**. In such a case, the unit of measure used must act as a common denominator; perhaps sales or percentage of capacity must be used.

Variable Cost. A variable cost is one that varies in total as output varies. The variance in the total amount of the cost may or may not be proportional to the variance in the output. In accounting, **straight line relationships** are usually assumed; consequently, it is not uncommon to find variable costs defined as those

costs which increase proportionately with increases in volume. If this definition is used, the unit variable cost is constant. The assumption of linearity is justified if the change in output is not too great; however, if output changes are too large, the variable cost may not be linear (constant per unit). This could be caused by changing prices or diminishing returns. Variable cost is usually looked upon as the accountant's attempt to measure **marginal costs.** If marginal costs are constant per unit of output, variable and marginal costs are the same.

It is difficult to give examples of variable costs because whether a cost is variable or not depends on several factors:

1. The length of time chosen for the analysis.
2. The magnitude of the change in volume.
3. The unit used to measure volume

Vance (Theory and Technique of Cost Accounting) states: "The amount of direct materials and direct labor used increases or decreases about the same as the increase or decrease in the volume of production. These costs, and other costs that fluctuate directly with production, are called variable costs." This may be true in some situations, but direct labor, for example, may not be variable in a firm which has a guaranteed annual wage agreement. Even in the absence of a guaranteed annual wage agreement, a firm may be able to increase volume by 5% with no additional direct labor cost. On the other hand, a 20% increase in output may cause an increase in the direct labor cost. Devine (Cost Accounting and Analysis) points out that "The accountant should remember also that costs which are fixed in the short run may be variable if the period is long."

There are many other factors besides volume that affect the amount of cost For example, some costs are variable with the price level; others show a seasonal variance within a particular firm. If variable costs are used in decisions and in rate determination where volume is an important factor, the other factors affecting cost must be adjusted in order to establish the influence of volume on the cost changes. In this sense the relationship between cost and volume is a causal relationship.

Whether or not a cost is variable depends on the problem or the decision at hand. There is no single division of costs into variable and fixed classifications which will serve all purposes. This is expressed by Goetz (Management Planning and Control) as follows:

> The growing frequency of division of costs by accountants into fixed and variable components may show the beginning of an awakening to economic and managerial problems However, thus far the development has been damned by a philosophy of absolutism, a search for a single-valued truth, an assumption that a single division of costs between fixed and variable components can be found that will be true for all purposes and under all conditions

Fixed Cost. A fixed cost is usually defined as a cost which remains constant in total regardless of changes in volume. The **fixed cost per unit of product** varies inversely with the number of units produced. As a matter of fact, before the fixed cost per unit can be determined, it is necessary to specify the number of units.

Differences of opinion exist among accountants as to the proper definition of fixed cost. In some cases the term "fixed" means fixed in total amount rather than fixed in relation to changes in output or volume. In some cases these definitions seem to be used interchangeably. Usually it is recognized that fixed costs are costs fixed in relation to volume; however, this element of cost can change from period to period but not because of volume. Real estate taxes, for example,

are usually not affected by volume changes from period to period; but there is a possibility that the tax cost can vary in amount with other forces, such as a change in tax rates. The same might be true of supervisory salaries which were not affected by volume but were affected by changes in wage rates.

In some cases one accounting method may make a cost appear as variable while another method may make the same cost appear as fixed. **Depreciation methods,** for example, may have this effect. Depreciation computed on a **straight line basis** may make the depreciation a fixed cost while the same cost may appear to be variable if the **units-of-output method** is used. Gordon (American Economic Review, vol. 38) has referred to this as the ". . . accountant's miracle of converting fixed cost into variable cost." Regarding this problem, the NAA Research Series No. 16 (NAA Bulletin, vol. 30) states:

> Under some circumstances it may be necessary to consider whether or not the method of accounting fully reflects the facts. For example, if the economic life of a durable asset is determined by obsolescence or action of the elements due primarily to time, then depreciation is a fixed cost even though the accounting makes it vary with production. On the other hand, if the life of the asset is determined primarily by wear and tear due to use, then depreciation is a variable cost even though the accounting treats it as a fixed charge per year.

Semi-variable Cost. Sometimes certain costs show a mixed relationship when plotted against volume. These costs are known as semi-variable costs and contain both variable and fixed elements. Sometimes a linear relationship can be established when the semi-variable costs are separated into their respective elements. In other cases a cost is fixed over large volume ranges but increases in jumps at various stages of production. Vatter (Managerial Accounting) says, ". . . one foreman can easily supervise six, seven, eight, or maybe nine workers; but some number of supervisees will overtax the powers of a single foreman, and the group will have to be made into two, to maintain effective supervision." He points out further that two problems arise when such costs are encountered: (1) It is difficult to state with certainty just when the "steps" in the cost pattern will occur. (2) These cost relationships may not be the same for decreases in volume as for increases in volume.

The accompanying table indicates the effect of foremen's salaries on unit production costs. The same data are presented graphically in Fig. 6.

Capacity (%)	Direct Labor Hours (000's)	Foremen's Salaries	Cost Per Direct Labor Hour
0	0	$10,000	
10	10	10,000	$1.00
20	20	10,000	.50
29	29	10,000	.345
30	30	20,000	.667
40	40	20,000	.50
50	50	20,000	.40
59	59	20,000	.339
60	60	30,000	.50
70	70	30,000	.429
80	80	30,000	.375
90	90	30,000	.333
100	100	30,000	.30

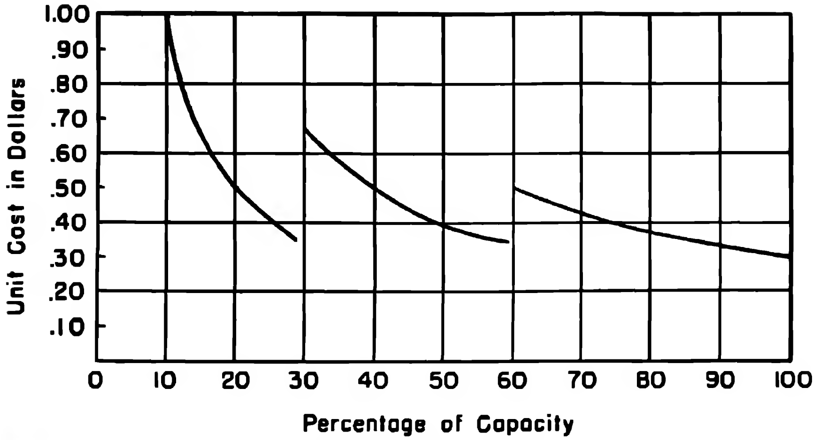


Fig. 6. Relation between volume of output and unit costs for foremen's salaries.

Erratic, or Irregular, Cost. Some costs, because of their irregularity, cannot be classified as fixed, variable, or semi-variable; therefore, they are referred to as "erratic," or irregular. They are described by Harris (Industrial Accountant's Handbook, Fiske and Beckett, eds.) as follows:

> Costs in the group are not even regular in their irregularity; in fact, they are erratic and freakish in their behavior pattern. An example is tool costs in some plants. The life of certain dies, whether belonging to the nondurable class or to the durable class, may and does vary greatly. Some dies crack shortly after being set up in machines. The same kind of die, made from the same quality of tool steel by the same toolmaker, at other times may last for days and weeks. As a result, the actual die cost in relation to units of product made by dies behaves in a very irregular manner. This is true no matter how efficient the metallurgist may be in testing tool steel and the dies made therefrom, and no matter how efficient the workmanship of the toolmaker may be.

METHODS OF SEPARATING VARIABLE AND FIXED COST. The following methods can be used to separate overhead costs into their variable and fixed components: (1) high-low points method, (2) scattergraph method, (3) least squares method, and (4) engineering or analytical method.

High-Low Points Method. The high-low points method, like the scattergraph and least squares methods, establishes the cost-volume relationship on a **historical basis.** All these methods produce a linear relationship between cost and volume, which may or may not be a good statement of the cost function.

The high-low points technique can best be described by an example. Assume that the following data have been reported for the past six months in a single department. (Although direct labor hours are used as the measure of volume in this example, other measures are certainly possible.)

Month	Direct Labor Hours	Cost of Operating Supplies
January	1,760	$520
February	1,960	570
March	1,760	520
April	2,020	585
May	1,860	545
June	1,680	500

The foregoing data show that the cost of operating supplies does vary with direct labor hours worked. By rearranging the data from the lowest to the highest number of hours, the **cost-volume relationship** can be determined.

Month	Hours	Total Cost of Operating Supplies	Change in Labor Hours	Change in Cost	Change in Cost Divided by Change in Labor Hours
June	1,680	$500	..	$00	$0.00
January	1,760	520	80	20	.25
March	1,760	520	0	0	0.00
May	1,860	545	100	25	.25
February	1,960	570	100	25	.25
April	2,020	585	60	15	.25

The preceding computation shows that as labor is increased by one hour, cost is increased at the rate of 25 cents per hour. This is the **variable cost rate** per direct labor hour. After finding this linear relationship, the fixed cost can be easily computed as follows:

Direct Labor Hours	Total Cost	Variable Cost ($0.25 per Hour)	Fixed Cost (Total Cost Less Variable Cost)
1,680	$500	$420	$80
1,760	520	440	80
1,760	520	440	80
1,860	545	465	80
1,960	570	490	80
2,020	585	505	80

Since a linear relationship is assumed, it is possible to establish the cost-volume relationship by choosing a high and a low point for both volume and cost and then computing the rate of change. For example, as hours increase from 1,680 to 2,020, variable cost increases from $420 to $505. Thus, as hours increase 340 hours, cost increases $85 or 25 cents per hour. The change in cost is the variable cost rate. The fixed cost can be determined by using either the high or the low point. Thus, the fixed cost is $80 (500 − 1,680 × 0.25).

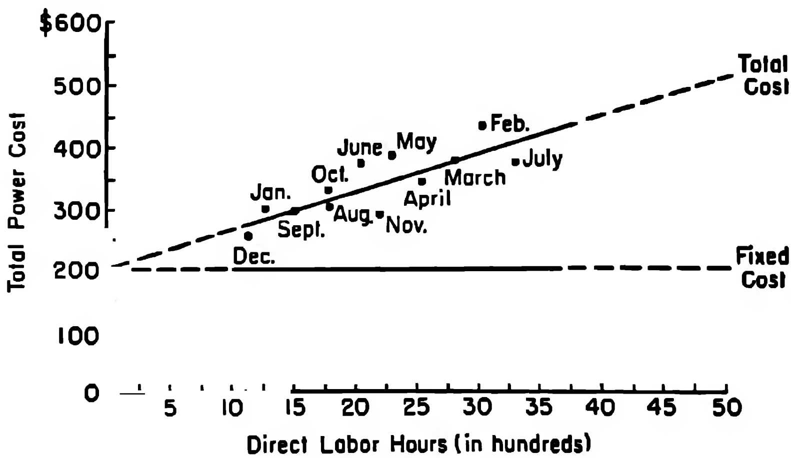


Fig. 7. Statistical scattergraph.

Scattergraph Method. This is a statistical method where a line is fitted to a series of data by observation. The slope of the line chosen represents the variable cost per unit while the Y-axis intercept of the cost line represents the fixed element of cost. In this method the volume is measured along the X-axis and the total cost is measured along the Y-axis. Several different combinations of cost and volume are then plotted on the graph and the cost function is drawn. Fig. 7 is a **statistical scattergraph** (sometimes called a "scatter diagram" or "scatter chart") which is plotted from the data given in the accompanying table.

Month	Direct Labor Hours	Total Cost of Electric Power
January	1,250	$ 300
February	3,000	425
March	2,750	375
April	2,500	350
May	2,250	360
June	2,000	375
July	3,250	365
August	1,750	300
September	1,500	300
October	1,750	325
November	2,175	300
December	1,125	250
Totals	25,300	$4,025

Each dot on the chart in Fig. 7 represents the power cost for a particular month. The **total cost** line is drawn by visual inspection. The slope of this line is the variable cost per hour of direct labor. The Y-intercept of this line is $200 and represents the **fixed element** in the power cost. The **variable element** can be determined by using either of the following methods:

1. **Variable cost rate determined from the total cost line.** If high and low values are read from the cost line, at 1,500 hours, the cost is $300; and at 3,000 hours, the cost is approximately $380. Thus, as hours are increased by 1,500, the cost increases $80. The variable cost rate per hour is $80 per 1,500 hours or 5⅓ cents per hour.
2. **Variable cost rate determined from the source data.** The total cost per year is $4,025, of which $2,400 (12 months × $200) is fixed. The variable cost is $1,625 ($4,025 − $2,400), which gives a variable cost rate of approximately 6.4 cents ($1,625 per 25,300 hours) per direct labor hour.

The difference in the variable cost rate derived by these two methods is due to the total cost line being fitted to the data by observation. However, the advantage of the scattergraph method is speed and simplicity rather than accuracy.

Least-Squares Method. The method of least squares can be used to fit a **regression line** to the type of cost–volume data given with Fig. 7. This method makes use of the straight line formula, $Y_c = a + bX$ where a is the fixed element of cost and b is the degree of variability. The regression line may be determined as follows: The slope of the cost line b is equal to $\Sigma xy/\Sigma x^2$ where $x =$ the deviation from the average of the volume $\overline{X}$, and $y =$ the deviation from the average of the cost $\overline{Y}$.

After the slope has been computed, it can be substituted in the formula $a = \overline{Y} - b\overline{X}$. The numerical figure may then be found for a, which is the element of fixed cost.

The example here (see accompanying table), adapted from Matz–Curry–Frank (Cost Accounting) is used to illustrate the least-squares method.

Col. 1 Month	Col. 2 Direct Labor Hours (000's) X	Col. 3 Cost of Light Y	Col. 4 Deviation from Average of 35,000 Hours * (Col. 2 − 35,000) x	Col. 5 Deviation from Average of $570 Light Cost † (Col. 3 − $570) y	Col. 6 x^2 (Col. 4 Squared) (000,000's)	Col. 7 xy (Col. 4 × Col. 5) (000's)
January	34	$ 640	−1,000	$ 70	1	−70
February	30	620	−5,000	50	25	−250
March	34	620	−1,000	50	1	−50
April	39	590	4,000	20	16	80
May	42	500	7,000	−70	49	−490
June	32	530	−3,000	−40	9	120
July	26	500	−9,000	−70	81	630
August	26	500	−9,000	−70	81	630
September	31	530	−4,000	−40	16	160
October	35	550	...	−20	0	0
November	43	580	8,000	10	64	80
December	48	680	13,000	110	169	1,430
Totals ..	420	$6,840	0	0	512	2,270

* Average of direct labor hours is 420,000 12 = 35,000.
† Average of cost is $6,840 12 = $570

The **variable and fixed costs** can be computed as follows:

1. Variable cost = $\Sigma xy, \Sigma x^2$ = 2,270 512,000 = $4.40 per 1,000 labor hours or $0.0044 per labor hour.
2. Fixed cost = $570 − (.0044 × 35,000) − $416. The formula for the cost of light in this example is as follows:

Total cost of light = $416 + .0044 per direct labor hour.

The regression line determined by means of this straight line formula expresses the average relationship of the cost data given the direct labor hours. The actual cost in any specific month, however, may vary considerably from the line and cannot be derived directly by means of the formula.

Devine (Cost Accounting and Analysis) points out:

A statistical measure of the reliability of the estimate may be taken by using the standard error of estimate. The formula for this measure is $\sqrt{\Sigma(Y - Yc)^2/n}$, where Y is the amount of the actual expense at all observed levels of output, and Yc is the amount of expense shown by the estimating line or equation at each level, and n is one less than the number of actual observations.

Analytical Method. The three methods previously discussed for separating variable and fixed costs rely on historical cost. As such, they may not be useful in cases where (1) there is no historical cost data available, or (2) the past cost data are unreliable because of changed conditions, such as a change in the state of technology. In such cases the analytical method may be used. This method is sometimes referred to as the **industrial engineering approach.**

Industrial engineers, along with members of the accounting and budget staff, study each activity or job in an attempt to (1) discover the best method of performing the function, and (2) establish the cost of performance. The use of this method is described in NAA Research Series No. 16 (NAA Bulletin, vol. 30):

Where no past experience is available, as with a new product, plant, or method, this approach can be applied to estimate the changes in cost that will accompany changes in volume. Foremen and supervisory personnel with direct responsibility under the budgets usually work with the industrial engineering staff in preparation of budgets by this method. The results are in effect standards, flexible with volume. Requirements for the most important cost factors are usually expressed in physical quantities (i.e., pounds of material, hours of labor, number of foremen, etc.). These physical budgets are then converted to dollar budgets by multiplying quantities by standard or anticipated prices.

LIMITATIONS OF USEFULNESS OF VARIABLE AND FIXED COSTS. There are some severe limitations on the usefulness of the variable and fixed cost classifications. Most of these limitations are due to the fact that cost is affected by many factors other than volume. The problems caused by these other factors make it difficult to measure variable and fixed costs with a high degree of accuracy. When linear functions are assumed and some method such as the least squares method is used, the cost function is a function of volume plus several other factors. The usefulness of such a function in making volume decisions is therefore severely impaired.

Wyer (NAA Bulletin, vol. 38) says, "The division of costs into categories of fixed and directly variable is a dangerous and misused concept, a veritable myth under the searchlight of considered analysis." His major complaint is not so much with this classification of cost as with the assumption that **cost-volume relationships** are usually characterized by straight lines. This is a measurement problem, however, and not necessarily a shortcoming of the classification concept itself. Wyer suggests that the straight line measurements of variable and fixed costs are limited by:

1. Time.
2. A given capacity range.
3. Price indices.
4. Managerial decision.
5. Product specification.
6. Product mix.

The Committee on Research of the National Association of Accountants (NAA Research Series No. 16, NAA Bulletin, vol. 30) emphasizes the need for intelligent interpretation of historical cost behavior:

> Actual experience with historical cost data shows that correlations with volume are often poor as indicated by a more or less random arrangement of the plotted points on the scatterchart. This is explained by the fact that numerous factors in addition to volume cause costs to vary. In a study of cost-volume relationships it is necessary to assume that these nonvolume factors affecting costs will remain constant for the period during which the conclusions are to be applied. Among the other such factors which cause costs to vary are: (1) changes in plant and equipment; (2) changes in products made, materials used, or methods of manufacture; (3) changes in organization, personnel, working hours or conditions, and efficiency; (4) changes in prices paid for cost factors; (5) changes in managerial policy toward costs; (6) lag between incurrence of costs and reporting of production; and (7) random influences such as strikes, weather, and wars.
>
> Concurrent operation of the above listed factors on costs tends to obscure the fluctuations due to volume alone. Hence some adjustment or selection of data is usually required before the rate at which cost should vary with volume can be established.

Other limitations on the use of the variable-fixed classifications are due to the heavy reliance on **historical cost**. Decision making is concerned with the future,

and historical costs can be used only as a guide to what the future holds. In a good many instances this guide has been very inadequate, even though at the time the decision was made, the information appeared to be reliable.

Vatter (The Journal of Business, vol. 43) says

> The separation of these two kinds of cost is admittedly somewhat imperfect, since often the net effects of output variations can be isolated with precision only by extended analysis—perhaps partial correlation techniques are required to establish such relations. But it is nevertheless true that categories of fixed and variable costs have been employed for budgeting purposes with quite satisfactory results, even though the relationships were determined by the use of simple techniques.

For further discussion, see "Other Cost Classifications for Decision Making" in this section.

Collecting Manufacturing Overhead Data

COLLECTION OF DATA IN FORMAL COST RECORDS. The collection of cost data in the formal records presents several difficult problems. There are so many varied potential uses of cost data for managerial decision-making purposes that it is almost impossible to anticipate them at the time the system is set up. Gillespie (Cost Accounting and Control) says, "The cost man will have to decide whether to do the extra work of recording required to keep the additional accounts or to do the analysis which will otherwise be required, by digging into the accounts after the end of each month, when the manager begins to ask questions."

The most complete method of making a **managerial decision** is to project the complete profit picture as it is affected by all the various alternatives. This is seldom a practical approach, and the short cut that is usually relied on is the comparison of cost figures which are readily available either from special analysis or from the existing records. There may be a temptation on the part of managers to use cost figures for purposes for which they were not intended; in so doing, the managers may misinterpret the effect of the various alternatives on the profit.

A **cost system** set up primarily for inventory costing or control may be quite unsatisfactory in furnishing data for decision making unless some changes are made. If misinterpretation is to be avoided in decision making, a special cost system may be desirable. The accountant may establish the primary need for information and build the system around this need. The alternative to a special system is to consider the potential use of the data as the requests are received and to conduct a special analysis for each request.

COLLECTION OF DATA FOR DECISION-MAKING PROBLEMS. If the cost system is set up especially for inventory costing, it may be desirable to require a special analysis for each decision-making problem. This method forces an evaluation of the readily available cost information to see if it will fit the need of the requesting department. This system has another advantage of forcing the requesting department to state specifically the use of the cost figure; in so doing, the user may specify the exact type of cost information he thinks is pertinent to the problem at hand. The disadvantage of this system is the increased cost of obtaining information.

A variation of this procedure would be to design the cost system with decision making in mind. No one decision, however, would predominate; thus, information and data would be recorded in their basic, natural state. The recording

procedure could be very flexible and would contain no allocations or reallocations of data to departments and products, etc. As the need for information arose, a special analysis could be made, but the basic data would have to be gathered especially for decision-making problems rather than for inventory or control problems. Since the use of the data must be specified for each information request, the chances of obtaining good cost information would be improved; no cost figure would be computed before it was specifically requested.

STEPS IN ACCOUNTING FOR MANUFACTURING OVERHEAD. The following steps are involved in accounting for manufacturing overhead cost:

1. Analyzing the cost transactions.
2. Entering the cost transaction on original records and summary sheets.
3. Journalizing the cost transactions.
4. Posting cost transactions to subsidiary ledgers.
5. Posting the transactions to the Manufacturing Cost Control account.
6. Proving the balance in the subsidiary ledger against the control account and tracing it through to the cost distribution sheet at the end of each accounting period.
7. Spreading the totals of direct charges over all departments affected thereby.
8. Distributing service department costs to other departments.
9. Applying costs to products.

Several of the above steps, while necessary for inventory costing or control, may not be necessary for decision-making.

No uniform plan is followed by industrial concerns for accumulating overhead costs. While there is a general pattern or routine procedure to be followed in cost accumulation, there are many recording methods which can be employed. Many cost systems in operation utilize a combination of the two basic plans—the use of manual methods or machine methods.

SOURCE, OR BASIC, DOCUMENTS. Certain source, or basic, documents are used in the accumulation of manufacturing overhead. There are different documents that can be used, four of which are illustrated here:

1. Purchase vouchers.
2. Stores requisitions.
3. Labor time tickets.
4. Repair and maintenance orders.

These source documents provide a record of the cost transactions which must be analyzed and accumulated in the proper account. To obtain accurate and useful information, it is necessary that these transactions be properly classified at their inception. Those charged with this duty must be thoroughly familiar with the names and code numbers of cost accounts as well as with the purpose or function of each account. An **accounting manual** must be provided if necessary.

Purchase Vouchers. Factory cost transactions recorded on purchase vouchers are those which represent charges in their entirety to the current month's operations and which increase obligations to outside creditors. These transactions are evidenced by **vendors' invoices** which are analyzed and classified in accordance with the chart of accounts and the accounting manual. The specific account charge is indicated by account number on the invoice. In addition, if a cost charge can be specifically identified with a particular department, it is also indicated on the purchase voucher. This voucher is the basis for payment and may be combined with the check in the form of a **remittance statement** (Fig. 8).

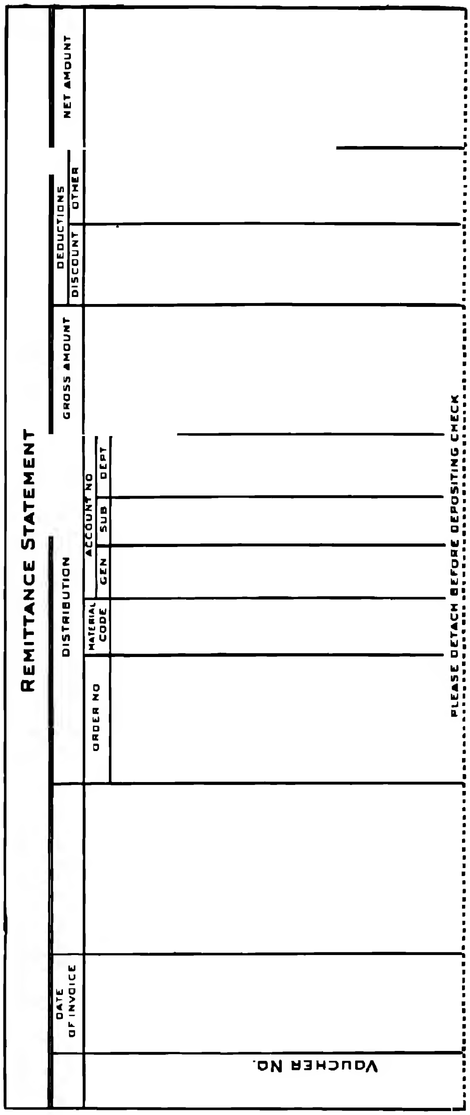


Fig. 8. Voucher check remittance statement.

From the viewpoint of cost accumulation and distribution, **account distribution columns** are the most important columns in the remittance part of the purchase voucher check. The subsequent posting of this information to other accounts is made on the basis of the purchase voucher.

Stores Requisitions. Stores requisitions cover cost charges made for items drawn from the stores and supplies inventory. Foremen, factory department heads, and their assistants are designated as the responsible persons to write requisitions. The requisitions should specify the account, code number, and department to which the cost applies (Fig. 9).

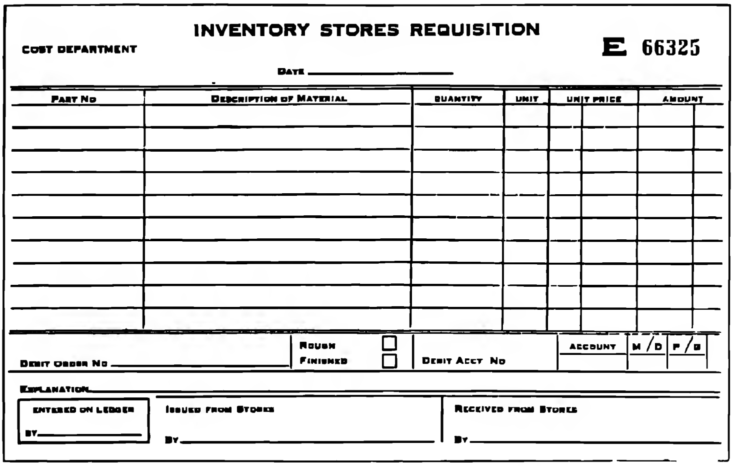


Fig. 9. Stores requisition for indirect materials and supplies.

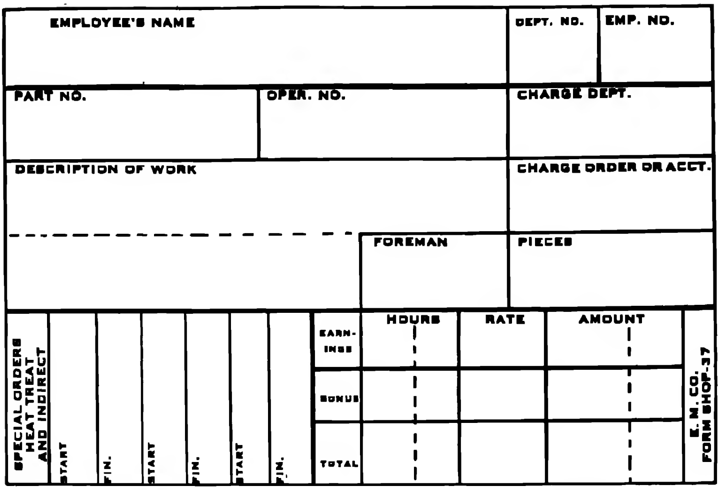
When an extensive departmental and subaccount chart of cost accounts is used, it is preferable to employ cost requisitions that contain only one item; the reason lies in the fact that several items may affect several account numbers, both as to debits and credits.

Cost accounts commonly affected by transactions involving stores requisitions are such items as fuel, lubricants, miscellaneous factory supplies, refractory materials, repair materials, shop office supplies, and small tools. (For a detailed discussion of materials accounting, see section on Materials.)

Labor Time Tickets. Labor time tickets are used for time worked by indirect laborers who are paid on an hourly rate basis. The timekeeper or workmen must be instructed to indicate pertinent data on the **daily time ticket** so that the proper factory cost accounts are charged for their time. These data include the indirect-labor occupation name and code number (or the cost code number) and the department to which the indirect labor applies (Fig. 10).

These labor time tickets serve as a basis for charging the labor to the various departments on a direct basis. If a workman works in more than one department, this time ticket information is used to assign his labor cost between the two or more departments. (For a detailed discussion of labor accounting, see section on Labor Costs.)

Repair and Maintenance Orders. Factory cost transactions pertaining to repair and maintenance work may be recorded on special **service repair orders.**

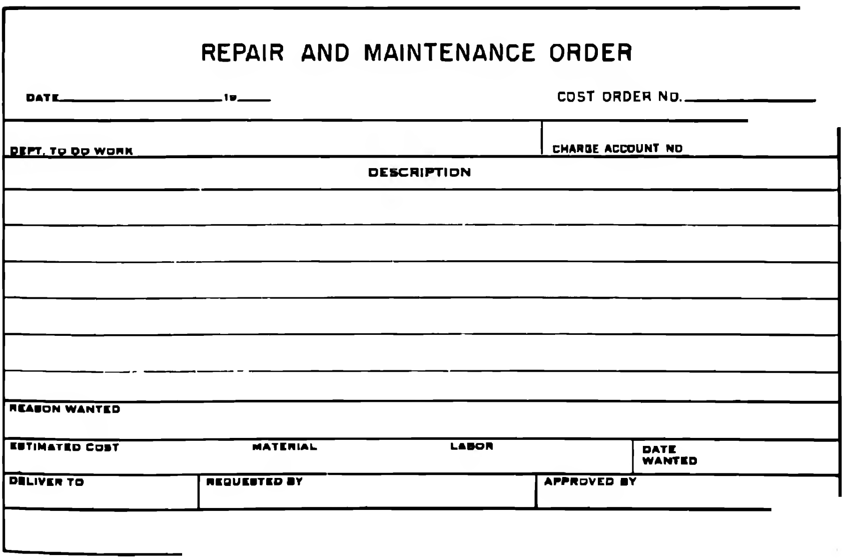


EMPLOYEE'S NAME | DEPT. NO. | EMP. NO.
PART NO. | OPER. NO. | CHARGE DEPT.
DESCRIPTION OF WORK | CHARGE ORDER OR ACCT.
FOREMAN | PIECES
SPECIAL ORDERS HEAT TREAT AND INDIRECT | START | FIN. | START | FIN. | START | FIN.
EARNINGS | BONUS | TOTAL
HOURS | RATE | AMOUNT
E. M. CO. FORM SHOP-37

Fig. 10. Indirect labor time ticket.

This form is illustrated in Fig. 11. Some of the cost accounts that may be affected by transactions recorded on repair and maintenance orders are:

1. Maintenance of factory automobiles.
2. Maintenance of factory buildings, grounds, and equipment.
3. Maintenance of roadways and railroad sidings.
4. Repairs of factory buildings, equipment, and machinery.



REPAIR AND MAINTENANCE ORDER
DATE ______ 19___ COST ORDER NO. ______
DEPT. TO DO WORK | CHARGE ACCOUNT NO
DESCRIPTION
REASON WANTED
ESTIMATED COST | MATERIAL | LABOR | DATE WANTED
DELIVER TO | REQUESTED BY | APPROVED BY

Fig. 11. Repair and maintenance order.

The repair and maintenance order is used much like the stores requisition. The department or individual requesting the repair and maintenance service uses this order as a basis for requisitioning the service from the repair and maintenance department. The order can then be used, after it has been properly completed by the repair department, as a basis for making charges to other service and producing departments. Such a charge is necessary for **inventory costing** and also for **control accounting.**

BOOKS OF ORIGINAL ENTRY. The following books of original entry are used in the accumulation of manufacturing overhead cost:

1. Voucher register.
2. General journal.
3. Factory journal.

The form of the books of original entry depends on the basic plan for the accumulation of overhead costs in the control account. If there is only one cost control account, only one column needs to be provided in the voucher register and other books of original entry in which costs are recorded. Where departmental cost control accounts are used, there are as many columns provided in the voucher register and other books as there are control accounts.

Voucher Register. Transactions which represent contracts with outsiders are recorded in the voucher register. The voucher register, for control purposes, usually contains all transactions which ultimately result in a cash expenditure. The voucher can be prepared and posted when the goods or services are received, such as when supplies or materials are purchased; or the voucher can be prepared and posted only when the payment is made, such as when certain supplementary payroll taxes are paid.

The posting media to the voucher register is either the purchase voucher discussed earlier (Fig. 8) or some type of **general voucher** (Fig. 12) which can be used in lieu of a purchase voucher. Regardless of the type of voucher used, the distribution of the cost is shown, and the debit entry is either made to one **manu-**

VOUCHER

In favor of The National Tool Company No. 1007

Date January 2, 19__

Distribution

Debit: 502 Small Tools:		Credit:	
Department 90	$ 589.27		
Department 91	642.87		
Department 92	81.07		
Department 93	491.63		
Department 02	88.96		
Department 03	5.94		
Department 06	19.50		
Account		Account	
500 Manufacturing overhead	$1,919.24	201 Vouchers Payable	$1,919.24

Fig. 12. Voucher showing account distribution.

facturing overhead cost control account or distributed between the departmental or other possible control accounts.

Fig. 12 could be recorded in the voucher register as follows:

1. The total of the voucher ($1,919.24) is debited to Account 500, Manufacturing Overhead. Subaccount 502 is debited in the manufacturing overhead ledger.
2. The credit is made to Account 201, Vouchers Payable, for the total amount.
3. The departmental cost distribution shown on the general voucher provides the necessary analysis for posting to detailed cost accounts contained in the departmental cost ledger or the cost distribution sheet.

Notice that this recording procedure could be varied so that **departmental control accounts** would appear in the voucher register. The subsidiary information would then have to be posted to a Small Tools subsidiary account maintained for each department. Also note that the general voucher contains both a debit and credit column so that it can be used to record any type of purchase or payment transaction.

General Journal. Many of the manufacturing overhead transactions are accumulated through the general journal. The general journal may contain a special column for Manufacturing Overhead, where overhead transactions are entered and accumulated until the end of the accounting period and are then posted in total to the Manufacturing Overhead Control account and to the subsidiary records.

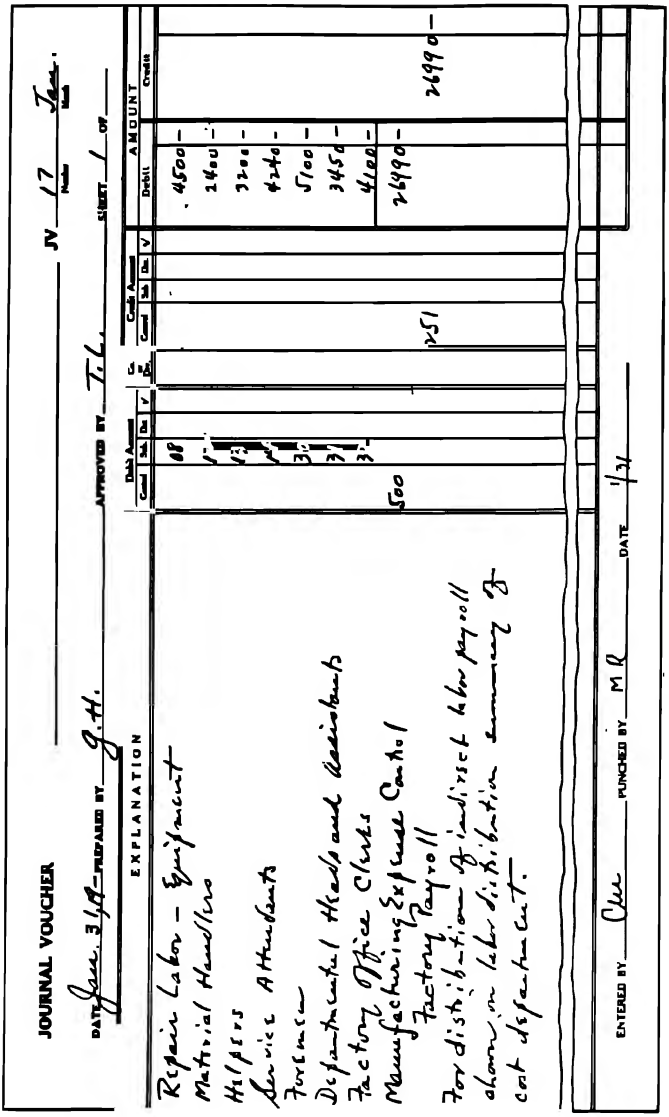
A **journal voucher** (Fig. 13) may be used in lieu of or as a supplement to the general journal. A single journal entry is placed on each journal voucher sheet, from which postings are made to the appropriate ledger and subsidiary accounts. The journal vouchers are then filed away and become the general journal record. Cost transactions for which journal entries are made on journal vouchers are principally end-of-month factory overhead adjustments. Some typical transactions are listed below:

1. Charges to Indirect Labor Cost account, taken from indirect labor distribution summary.
2. Spoilage costs obtained from defective work tickets.
3. Maintenance and repair charges prepared from repair orders.
4. Depreciation charges obtained from plant equipment ledger records and depreciation analysis work-sheet records.
5. Property insurance and taxes taken from work-sheet analyses.

The supporting evidence for the journal entry appearing on each journal voucher is represented by a variety of forms, the most common of which are (1) adding machine tapes which list figures taken from original or summary records, (2) engineers' reports, and (3) various cost-department work-sheet analyses.

Fig. 13 is a typical journal voucher. In posting this voucher, the credit is made to the Factory Payroll account which was used to record the payroll; the debit records the distribution of the payroll accumulated and paid during the period.

Factory Journal. A factory journal facilitates the posting process where the cost system provides for cost accounts to be kept in a separate factory ledger rather than in a general ledger. In such a case all cost transactions entered in the general journal or on journal vouchers involving factory cost accounts are entered in the factory journal or on factory journal vouchers. These factory journals are then posted to the factory ledger. In order to avoid duplication in



JOURNAL VOUCHER — JV 17 (Number) Jan. (Month)

DATE Jan. 31, 19— PREPARED BY G.H. APPROVED BY T.L. SHEET 1 OF

EXPLANATION	Debit Account Cont'l	Sub.	Dis.	✓	Co. or Div.	Credit Account Cont'l	Sub.	Dis.	✓	AMOUNT Debit	AMOUNT Credit
Repair Labor – Equipment		08								4500 –	
Material Handlers		[illegible]								2400 –	
Helpers		[illegible]								3200 –	
Service Attendants		[illegible]								4240 –	
Foremen		30								5100 –	
Departmental Heads and assistants		31								3450 –	
Factory Office Clerks		[illegible]								4100 –	
Manufacturing Expense Control	500									26490 –	
Factory Payroll						251					26490 –
For distribution of indirect labor payroll shown in labor distribution summary of cost department.											

ENTERED BY Clu PUNCHED BY MR DATE 1/31

Fig. 13. Journal voucher.

recording and to provide for self-balancing records, **reciprocal accounts** are often used. A general ledger reciprocal account appears in the factory journal, and a factory ledger reciprocal account appears in the general books, possibly in the voucher register. This procedure allows the factory cost clerk to report the cost part of a transaction while the general office reports the liability aspect of the transaction on the general books. (For further discussion and illustration of a factory journal and ledger see section on Basic Cost Records.)

SUBSIDIARY RECORDS FOR SUMMARIZING MANUFACTURING OVERHEAD. There are several subsidiary records prepared by the cost or general accounting department to provide information for monthly entries in the various journals mentioned earlier. For example, the monthly or yearly adjustment for depreciation, insurance, patent amortization, and other such adjustments are made in the general journal. However, the information for the entries must be summarized on some basic subsidiary record. There are many such subsidiary records, and they are used whenever they are found to be convenient. Where monthly journal entries are a composite of much detailed information, such records are probably necessary.

Certain of these basic subsidiary records may be kept for control reasons as well as for providing information for journal entries. The plant records, which are used to furnish depreciation information, may also be used as a type of **physical property inventory record** and thus provide certain physical controls over the property.

Of the many possible subsidiary records, the insurance register, the plant register, and the patent register will be discussed here.

Insurance Register. An insurance register provides a detailed record of each policy to show (1) the period write-off of prepaid insurance, (2) the end-of-month prepaid insurance to be shown on the balance sheet, (3) the insurance cost distribution to different departments or processes, and (4) the information on each policy, which might be used in making decisions regarding the proper amount of insurance. For example, the **policy expiration dates** shown in the register can be used to make certain that adequate insurance protection is maintained at all times.

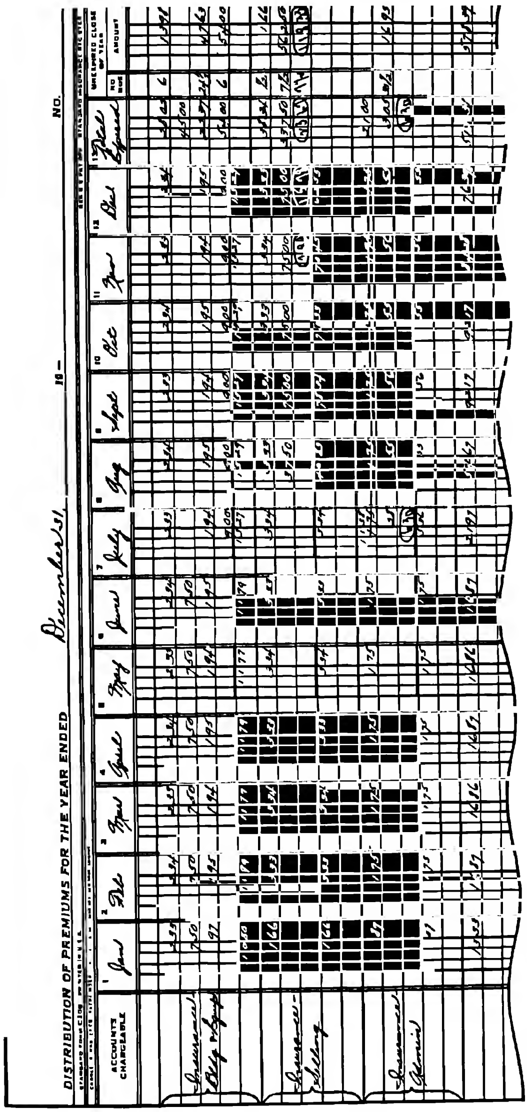
Fig. 14 illustrates a possible form that might be used for an insurance register. The left half of the form provides the necessary identification of each policy, the information on new policies purchased during the period, and the unexpired amount of prepaid insurance at the beginning of the period. The right half of the register provides space for a complete month-by-month record of write-offs and a final summary of total expired and total unexpired insurance at the end of the year. The sum of the last two columns should, of course, equal the sum of the new insurance purchases and the total brought forward from the prior year. This information provides a check on the accuracy of the detailed computations for write-offs. The policies can be grouped according to the **type of coverage.** (If there are many policies, each type may be listed on a separate page.) By grouping policies in this manner, each group or page refers to a specific cost or expense account. This grouping may not eliminate the need for further analysis.

Plant Register. The plant register, sometimes called the **equipment ledger,** is a subsidiary record that provides details supporting the **fixed asset control accounts** for plant buildings, machinery and equipment, and other tangible fixed assets subject to depreciation. This record is usually designed in loose-leaf form for use in binders, as a card for file drawers, or as a tabulating card. The

NO RECORD OF INSURANCE POLICIES FOR YEAR ENDED December 31, 19—

POLICY NO	NAME OF COMPANY	AGENT	KIND OF INSURANCE	AMOUNT OF POLICY	PERIOD COVERED FROM	PERIOD COVERED TO	RATE	AMOUNT OF PREMIUM	UNEXPIRED PREMIUM FORWARDED NO MOS	UNEXPIRED PREMIUM FORWARDED AMOUNT	CANCELLATION DATE	CANCELLATION AMOUNT
			AMOUNTS FORWARDED									
105268	Hartford Fire Ins Co	Allen & Jones	Fire - Bldg.	42 000	6 30 38	6 30 41	.20		18	[illegible] .00		
111326	Metropolitan Ins Co	" "	Fire - Equip	50 000	7 1 39	7 1 40	.18		6	[illegible]5 00		
146892	Hartford Fire Ins Co	" "	Fire - Bldg	35 000	1 15 40	1 15 43	.20	70 00				
113490	Metropolitan Ins Co	" "	Fire - Equip	60 000	7 1 40	7 1 41	.18	108 00				
1895	Glenns Falls	Allen & Jones	Fire - Mdse	10 000	1 15 40	1 15 41	.40	40 00				
32794	Continental Casualty Co	R. H. Kane	P.L. P.D. F. & T. Trucks		8 15 40	8 15 41		900 00				
32794	Continental Casualty Co	" "	P.L. P.D. F&T Trucks								11 15 40	[illegible]
28309	Lloyds of London	Allen & Jones	Liability	5 000	1 15 40	1 15 41	.42	21 00				
658043	Continental Casualty Co	R. H. Kane	Liability	5 000	7 15 40	7 15 43	.40	20 00				
28309	Lloyds of London	Allen & Jones	Liability								9 15 40	[illegible]
								1 159 00		[illegible]7 00		[illegible]

(Left page of register)



Circled items in red.

(Right page of register.)

Fig. 14. Insurance register.

principal items provided for on the plant register are factors which record the original cost of the asset and the depreciation applicable thereto. The reverse side of the ledger card usually provides space for a **repair and maintenance record.** Such a record also serves as a **physical perpetual inventory.** The Accountants' Handbook (Wixon, ed.) gives a detailed discussion of possible records that could be used for fixed assets.

The **original cost** of equipment includes the invoice price, transportation and handling charges, materials and labor costs incurred in its installation, and any other cost incurred prior to placing the machine in operation. The total cost, less scrap value, becomes the basis for computing the **annual depreciation charges.** The latter is usually divided by 12 to provide the monthly depreciation cost. In practice, the scrap value is often disregarded. The totals of the monthly depreciation figures for fixed assets may be recorded on cost department summary records to form the basis for the end-of-month depreciation-adjusting journal entry. The columnar headings for this type of summary work sheet could be:

1. Name of asset (including an identification number if necessary).
2. Date acquired.
3. Estimated life.
4. Depreciation: rate, annual amount, monthly amount.
5. Accrued depreciation allowance.
6. Undepreciated cost.

Separate columns may be provided for each month, since there may be some additions to, or deletions from, the list of depreciable assets. In practice, however, such monthly columns may be unnecessary. To speed up monthly statements, month-end adjustments are reduced as far as possible to a fixed routine. For depreciation, an average amount may be charged monthly, with a final adjustment made at the end of the year based on a more exact computation revealed by the plant register.

Patent Register. The patent register is a subsidiary ledger in which are kept the details necessary to account for and control each patent. As a patent is capitalized in the general ledger account, an auxiliary record is prepared for the patent register (Fig. 15). Monthly **patent amortization cost** on each patent as obtained from the patent register, is accumulated on a work sheet similar to that used to summarize depreciation charges. This type of record may be maintained for control purposes even though the patent is not capitalized or is completely written off.

LEDGER SUMMARY OF MANUFACTURING OVERHEAD. The book of accounts for summarizing manufacturing overhead can take the form of either (1) the general ledger or (2) the factory ledger.

General Ledger. The general ledger encountered in accounting for manufacturing overhead is no different from the general ledger used for other accounting purposes. It is a collection of accounts which is used to summarize various totals for an accounting period or to reflect certain account balances at the end of a period. If manufacturing overhead is summarized in the general ledger, it is necessary to include certain cost accounts together with the general accounts. The choice of the accounts to be included depends on the amount of subsidiary and detailed information called for, as well as what part of this detail is to appear in the form of subsidiary records outside the general ledger.

Factory Ledger. A factory ledger is sometimes used together with the general ledger in accounting for the entire business unit. The cost accounts as well as any

Patent Number________ **Department in which used**________

Description of Patent________________________________

Date Acquired____________ **Original Cost**________

Period of Amortization________ **Annual Amortization**_____

Monthly Amortization____

Date	Cost	Amortization		Date	Cost	Amortization	
		Annual	Accumulated			Annual	Accumulated

Fig. 15. Patent register.

other accounts which pertain to the factory operation may be extracted from the general ledger and included in a separate factory ledger. Matz–Curry–Frank (Cost Accounting) state:

> It is not uncommon for administrative, sales, and accounting offices to be far removed from factory sites, and of course the same company may operate several factories or sales offices in different parts of the country. If the factory is located some distance from the offices or if the manufacturing requires a great number of accounts, it becomes practical to do a portion of the accounting at the factory.

The choice of accounts to be included in the factory ledger depends on the individual situation. If sales are made from the factory, and the billing is done by the individual units of the business, there is a need for such accounts as Cash, Accounts Receivable, Sales, and related accounts in the factory ledger. If these functions are performed by the home office, however, there is no need for these accounts to appear in the factory accounting system. The business has the same type of choice regarding the payment of the factory payroll; i.e., the payroll can be paid by the factory or by the general office.

The factory ledger usually includes a General Ledger account, and the general ledger usually includes a Factory Ledger account. Such a procedure permits the two ledgers to be self-balancing and yet makes it unnecessary to duplicate accounts in the two records. When the statements are prepared for the entire business unit, these two reciprocal accounts are eliminated. (For further discussion and illustration of a factory journal and ledger see section on Basic Cost Records.)

Structure of Ledger Accounts. In general, the structure of cost accounts in the ledger may be developed by:

1. Including a cost account for each object of cost expenditure in the ledger to serve as a control account. A summary account, Manufacturing Overhead, can

be used for closing purposes. The various subsidiary records under this procedure can be used to collect departmental cost detail. A Standing Order form may be used as such a subsidiary record.

2. Including only one Manufacturing Overhead Control account in the ledger and collecting all detailed information in a subsidiary record. The subsidiary record in this case can be a Manufacturing Cost ledger in which an account appears for each item of cost classified on an object of expenditure basis. If departmental cost information is collected, a Standing Order form similar to the one shown in Fig. 4 can be used.

The second procedure specified is illustrated by Figs. 16, 17, and 18. The account shown in Fig. 16 would serve as the Manufacturing Overhead Control account and would be the only overhead account in the ledger. Postings to this account would be made from the voucher register (V) and the various journal vouchers (JV). The subsidiary information, which is a list of accounts by object of expenditure, appears in the manufacturing overhead cost ledger (Fig. 17). If departmental information is required, another subsidiary record must be used containing the type of information illustrated in Fig. 18 for one department.

19__ 500 Manufacturing Overhead (Control)

Jan. 31	V1	$ 6,550 24	
31	JV1	2 968 65	
31	JV2	386 00	
31	JV3	802 64	
31	JV4	2,401 89	
31	JV5	26,990 00	
31	JV6	4,146 95	
31	JV7	4,075.60	
31	JV8	420 00	
31	JV9	25,129 18	
31	JV10	1,409 00	
31	JV11	1,475 00	
31	JV12	723 33	
31	JV13	433 33	
		$77,911.71	

Fig. 16. Manufacturing overhead cost control account.

Under the first procedure mentioned, the accounts in Fig. 17 would appear in the general or factory ledgers, and the Manufacturing Overhead account (Fig. 16) would be used only as a summary account in the ledger. In such a system, the Manufacturing Overhead Cost account would probably be used as a Manufacturing Overhead Applied account, where the credit side would be used to record the application of overhead and the debit side would be used to summarize the actual overhead. If the need for **departmental cost information** is to be satisfied, a type of subsidiary record, illustrated in Fig. 18 for the engineering department, could be used.

USE OF MECHANICAL EQUIPMENT. The use of mechanical equipment to aid in the accumulation of manufacturing overhead may range from the use of a single adding machine to the use of an integrated data-processing system. It is difficult to imagine a modern office without several machines to aid in the recording of various types of data. The nature of the machines as well as the amount of recording done by machines rather than by manual methods depends on many factors, among which are the size of the organization, the desired information, the complexity of the accumulation problem, and the volume

MANUFACTURING OVERHEAD COST LEDGER

For January, 19_

501 Factory Supplies	JV1	$2,968.65
502 Small Tools	V1	$1,919.24
503 Factory Office Supplies	V1	$ 280.79
504 Fuel	V1	$3,650.00
505 Water	JV2	$ 386.00
506 Defective Work Losses	JV3	$ 802.64
507 Repair Material Equipment	JV4	$2,401.89
508 Repair Labor, Equipment	JV5	$4,500.00
509 Miscellaneous Factory Supplies	V1	$ 400.21
510 Workmen's Compensation Insurance	JV6	$4,146.85
511 Social Security Taxes	JV7	$4,075.60
512 Material Handlers	JV5	$2,400.00
513 Helpers	JV5	$3,200.00
514 Service Attendants	JV5	$4,240.00
530 Foremen	JV5	$5,100.00
531 Departmental Heads and Assistants	JV5	$3,450.00
532 Factory Office Clerks	JV5	$4,100.00
550 Medical Services	V1	$ 300.00
551 Patents Amortization	JV8	$ 420.00
552 Depreciation, Building	JV9	$2,250.00
553 Depreciation, Equipment	JV9	$22,879.18
554 Insurance, Building	JV10	$ 147.00
555 Insurance, Equipment	JV10	$1,262.00
556 Taxes, Building	JV11	$1,475.00
557 Maintenance, Building	JV12	$ 723.33
558 Relining Expense	JV13	$ 433.33

Fig. 17. Manufacturing overhead cost ledger.

of data to be handled. Usually, the smaller the office, the greater the reliance on simple, multi-purpose mechanical aids. This type of simplicity makes it possible for all personnel to operate the machines, and the cost of maintenance and repair is usually less than on the complicated type of data-processing equipment.

01 Engineering Cost

19—			
Jan. 5 Factory office supplies ..	V1	$ 127.90	
31 Miscellaneous factory expenses	V1	22.93	
31 Workmen's compensation insurance	JV6	76.50	
31 Social security taxes	JV7	102.00	
31 Dept. salaries	JV5	1,050.00	
31 Factory clerks	JV5	1,500.00	
31 Depreciation, building ..	JV9	120.00	
31 Depreciation, equipment.	JV9	166.67	
31 Insurance, equipment ...	JV10	6.00	
31 Insurance, building	JV10	8.00	
31 Taxes, building	JV11	80.00	
31 Repairs and maintenance, building	JV12	40.00	
		$3,300.00	

Fig. 18. Engineering cost account.

To select the proper type of equipment to be used, some kind of **feasibility study** is usually required. Some of the important factors to be considered in the selection of equipment are:

1. The cost of the equipment.
2. The estimated economies of operation.
3. The availability of the equipment and repair and maintenance service.
4. The compatibility of the new equipment with existing equipment.
5. The flexibility of the equipment in terms of capacity and work scheduling.
6. The previous experience of the company in using equipment.
7. Employee preferences and morale.

For a further discussion of feasibility studies and factors in selection of machine applications, see section on Basic Cost Records.

In recent years there has been a marked trend in some companies toward an **integrated data-processing system**. If such a system is contemplated, factor (5) becomes a very important consideration in the selection of equipment. The objective of such an integrated system is to coordinate all machines so that the data are processed in a continuous and automatic manner; i.e., (1) the original data are recorded at their point of origin in a mechanical form, (2) the data are processed exclusively in a mechanical manner, and (3) all processing of data is integrated so that the original data in mechanical form serve all subsequent applications. The mechanical handling of data, without manual intervention to handwrite or key punch, is the characteristic that distinguishes an integrated data-processing system from other systems which are only partially integrated.

FLEXIBILITY OF MACHINE RECORDS. The many potential uses of accounting data place a premium on flexibility. Goetz (Management Planning and Control) points out that one method of obtaining the desired flexibility is through the use of various types of mechanical equipment. Whether the system is an integrated one or consists of only a small amount of mechanical equipment, the flexibility of the system is improved. For example, if **punched cards** are

used, they can be punched so that each part of the transaction is recorded separately (if the transaction is nonhomogeneous); yet the entire transaction can be punched on each card. The data can then be summarized in a variety of ways by use of a sorting machine. Once the use of the data is determined, or if a special need arises, almost any subtotal of the original data can be computed by sorting and re-sorting the cards.

Use of Tabulating Equipment. Although there are many machine systems which can be used for accumulating manufacturing overhead, only the use of tabulating equipment and punched cards is described in this section. In such a system the punched card can be the sole original record used. Although the standard cards are uniform in size, they can be designed in many forms to fit the specific needs in accumulating overhead cost. In general, the design of these cards provides two **basic card styles**:

1. A tabulating card which provides no space for handwriting. It is designed in fields or zones (containing a varying number of columns) which provide spaces for punching holes that represent the data to be accounted for. The punching is done from some handwritten original record.
2. The tabulating card may be a dual card. It provides spaces for writing the original data or transaction on the card itself, in addition to columns for punching handwritten data therein. The dual card may eliminate the need for preparing some other preliminary original record.

In using tabulating equipment, it is necessary to construct a **standard set of account numbers** for overhead accounts. Morris (NAA Bulletin, vol. 37) reports the experience of one company which established a numbering system consisting of four digit numbers, of which the first two digits identified the department and the last two digits identified the cost account. Account No. 8111 indicated the accounting department (81) and supplies (11), for example. In this system, 11 **standard accounts** which were common to all departments were used:

01 Payroll
02 Overtime
08 Social Security
09 Telephone, Telegraph, and Expenses
11 Supplies
12 Work by Other Departments
13 Repairs and Maintenance
14 Research
15 Sundry
16 Travel and Entertainment
20 Obsolete Material

By using the foregoing cost classifications, together with departmental numbers, the costs could be summarized on a company-wide basis, and also special reports could be prepared for the departmental managers.

Journalizing. With the use of punched-card accounting, the **journal entry** is replaced by punching the basic data onto the punched card. The source documents used as a basis for card punching are usually standardized as much as possible so that the key punch operator can use the same routine for each punching operation. Morris (NAA Bulletin, vol. 37) mentions four basic documents from which the key punch operator works.

1. **Vouchers.** Vouchers are prepared throughout the plant and are forwarded to the accounting department for payment. After payment, the invoices and vouchers are sorted by the accounting department into batches and are sent

to the tabulating department where punched cards are prepared. The various account numbers are charged and Accounts Payable is credited for the total of the batch.

2. **Journal entries.** The journal entries are prepared by the accounting department and are forwarded by batches to the tabulating department. The journal entry form is very much like a journal voucher. The tabulating department returns the information with a ledger control listing to the accounting department.
3. **Work cards.** The work cards are made up by individuals performing productive work in standard cost departments. This document serves as a basis for the payroll charge to jobs and work in process. After the information is tabulated from the work cards, a listing of the individual's time is made by the tabulating department; this is checked back against the individual's clock card.
4. **Cash receipts.** At the end of each day, the cash receipts are totaled, and this total is used as a control for the bank deposit. A recapitulation of the receipts forms the basis for the total debit to Cash, and the individual receipts provide information for the credit part of the entry.

Morris reports that each of these basic documents has a code number which appears on the punched card and on any subsequent listings. This, of course, provides a **balancing medium.** Since the cards are filed according to the type of source document, any lost punched cards or errors can be traced by sorting and totaling the remaining cards according to category and then comparing this total with the batch totals. The date punched onto the card is the same as the date on the source document; consequently any lost cards can be identified.

Posting and Summarizing. After the basic information has been punched into the card, posting and summarizing the information is merely a matter of sorting the cards and tabulating the results. The actual **printing** or **tabulation** of the results is done whenever convenient or when the information is needed. In the system described by Morris, listings were made when batches of information were processed. The printed listings were returned to the accounting department along with the source documents.

At the end of the accounting period, after all the source documents have been processed by the tabulating department, a **trial balance** can be printed and sent to the accounting department. After the various temporary accounts have been closed, it is possible for the tabulating department to run the balance sheet for the accounting department. By re-sorting the basic information, the departmental cost and expense summaries can be printed and sent to the department heads involved.

Morris (NAA Bulletin, vol. 37) states:

When the balance sheet has been prepared and forwarded to the accounting department, the tabulating department prepares the monthly departmental expense statements for each of the departments which are on a budget basis. These departmental expense statements show the budget, actual, over and under, and budget changes for the month and year-to-date on each item charged to the department. The department head is also provided with the additional information, listed below, which supplies the detail of all charges appearing on the expense statements, and the accounting department is then furnished with the ledger sheets also enumerated.

For Operating Departments:

1. Ledger control listing.
2. Manufacturing job order listing.
3. Mechanical job order listing.
4. Listing of supplies requisitioned from stock room.

For Accounting Department:
1. General ledgers.
2. Expense ledgers.
3. Personnel ledgers.

As can be seen from this discussion, the types of reports that can be prepared from the punched cards are almost endless in number. By proper sorting techniques, information can be prepared for special studies as the need arises. (For a more detailed discussion of tabulating methods, see section on Basic Cost Records.)

ELECTRONIC DATA PROCESSING. The development of the electronic computer has opened up a completely new field of possibilities for accumulating information. Electronic data processing is one segment of the whole field of **integrated data processing.** Integrated data processing can be achieved through the use of electronic machines.

In describing electronic methods of data processing, Kozmetsky and Kircher (Electronic Computers and Management Control) state: "In general, it is usually possible to think of the processing requirements of a company in terms of the amount of raw data which must be recorded (input), transmitted and manipulated (processor), and the reports and records which must be prepared (output). In an electronic system, the **input media** are usually in the form of magnetic tapes, punched cards, or paper tapes. The **manipulation** function has been described by Haskins & Sells (Data Processing by Electronics) as follows:

> In the manipulation function of record keeping, all the assembly, sorting, classification, reference, and arithmetic operations are performed automatically within the components of the system, directed by a series of stored instructions, called a program. It is mainly the performance of the manipulation function that sets apart the electronic system as unique, and it is there that the electronic system gains its greatest advantage over others. Storage capacities of the system make possible the retention of data from master files, carry-forward balances, intermediate results, and the like, thus obviating the need for temporary filing, separate cross references, and other manual handling. Access to stored information, intercommunication within the system, computation, and the making of decisions—all required in the manipulation function—occur at electronic speeds.

The **output** part of the electronic system is either in a form suitable for more processing only or in the form of printed records. In the first form the output is usually on a punched card or a tape and may be used as another input at a later time. The printing of **terminal reports** is done by mechanical printers or some type of electrical or electronic printer. (See section on Basic Cost Records for a more detailed discussion of electronic data processing.)

Kozmetsky and Kircher (Electronic Computers and Management Control) state that the following advantages, through electronic data processing, are possible in a system for planning and control:

1. Provide more useful information concerning operations, for use in making better decisions.
2. Enable management to relate the procurement, production, and sales programs for each division in a way that results in the largest profits for the company as a whole.
3. Help management to make the best allocation of financial and other resources.
4. Eliminate certain management functions and strengthen others.

SECTION 8

DISTRIBUTION OF MANUFACTURING OVERHEAD

CONTENTS

CONTENTS (*Continued*)

SECTION 8

DISTRIBUTION OF MANUFACTURING OVERHEAD

Basic Considerations

ROLE OF OVERHEAD DISTRIBUTION. Careful, accurate distribution of manufacturing overhead is fundamental to good cost accounting. It is the area where some of the greatest difficulties, both in principle and practice, are encountered. Blocker and Weltmer (Cost Accounting) state, ". . . the most complex problems of cost accounting revolve around the measurement and distribution of overhead costs."

The distribution of manufacturing overhead is usually an important link between the first step of **accumulating overhead costs** in the accounts and the final step of **assigning overhead costs** to products on some reasonable basis.

REASONS FOR DEPARTMENTALIZATION. There are two reasons why the departmentalization of factory overhead is desirable: better **control** and better **costing** of jobs and products. Referring to the first reason, Matz–Curry–Frank (Cost Accounting) indicate that closer control is made possible because departmentalization of the costs incurred puts them under the responsibility of a foreman or manager. It is believed that better costing of jobs or products grows out of departmentalization because it makes possible the allocation or assignment of overhead to production on a **departmental** rather than a **plant-wide basis.** Only in the rare cases where there is either only one product, or where all producing departments contribute in uniform proportion to the fabrication of every product, can the assignment of all overhead on a plant-wide basis be reliable.

For a further discussion of **departmental** versus **plant-wide** overhead rates, see Departmentalization of Cost in the section on Accumulation of Manufacturing Overhead.

NATURE AND LIMITATIONS OF OVERHEAD COST DISTRIBUTION. Distribution of manufacturing overhead consists of apportioning or assigning the various overhead costs to the several departments or otherwise defined divisions of the factory. This distribution is followed by a redistribution of the costs assigned to certain departments, to the end that all costs are assigned to the departments that physically fabricate the products. The distribution may be strictly according to the **formal departmental arrangement** prevailing in the plant. Not infrequently, however, this is supplemented in some instances (for cost accounting purposes) by ignoring the organizational boundaries and recognizing, instead, various **cost centers** that seem to be logical points for the accumulation of costs. A department may be subdivided into two or more such cost centers for cost accounting purposes.

Usually the cost centers have a physical reality; sometimes they do not. Reitell and Harris (Cost Accounting Principles and Methods) say, "A cost center may not be a physical entity. It may occupy no space. It may be a phantom."

An example is occupancy expense or building expense. The account for this center can be used to collect or assemble all the costs relating to the occupancy of the structure. Grant (Basic Accounting and Cost Accounting) refers to this type as a **nominal cost center,** stating that it is ". . . established for bookkeeping convenience to summarize certain closely related expenses."

The assignment and reassignment of overhead costs to the cost centers (whether formal departments or divisions of convenience) is complicated by two characteristics of most overhead costs. They are, by nature, **joint** or **common** costs, and in addition they have different degrees of **variability.** A third factor that may complicate the distribution process is the desire to apportion the costs on the basis of responsibility or **controllability.**

Joint Nature of Overhead Costs. The incurrence of an overhead cost either benefits more than one department or division or, if limited to a single department, the benefit is common to all the activities within that portion of the plant. To some degree, every overhead cost is **joint**; it is that quality, in fact, that makes it overhead. Vatter (Accounting Review, vol. 20) points out that overhead costs are joint also in the sense that many such costs are incurred jointly. For example, depreciation, insurance, property taxes, and maintenance and repairs normally go together.

Variability of Overhead Costs. Another feature of overhead costs that complicates their distribution is the fact that some change very little, if at all, from period to period regardless of the degree of productive activity; some are almost completely fixed as to amount per period within certain ranges of activity; and others change as activity or production changes. Depreciation of buildings is a good example of the first class, superintendence of the second, and consumption of factory supplies the third.

Controllability of Overhead Costs. The control of manufacturing overhead is facilitated if it is distributed or assigned on the basis of **responsibility for incurrence.** In this connection the suggestion is made in the Uniform Accounting Manual for the Electrical Manufacturing Industry that, "While more than one cost center may be established for a supervisor's activity, generally a cost center should not include the activities of more than one supervisor." The general principle of assigning overhead costs on the basis of responsibility cannot always dominate, however, since often a cost may be assigned to a department because of a benefit received, even though the department manager had no control over the incurrence of the cost. **Occupancy** and **general factory administrative costs** are cases in point.

Heckert and Willson (Controllership) make the following statement regarding the **control of service department costs:**

From a cost control viewpoint, the service department supervisor should be held responsible for any cost over his budget. The departments using the services should be charged at a standard rate for the actual services used, differentiating between the fixed and variable costs, of course. In this manner the using department can be held fully responsible for excess service costs in that department, since no share of the inefficiencies or wastes of the service department are charged against the productive department. From the cost control viewpoint, the service supervisor is responsible for efficiently operating his department at whatever level of service required by the using departments, and as measured by the flexible budget applied to the level of activity. The productive departmental supervisors, on the other hand, are responsible for the quantity of service consumed.

For a general discussion of the problems of controlling costs, see the section on Cost Control, Budgets, and Reports.

Allocation of Overhead Costs. The choice of **bases for distribution** of manufacturing overhead is complicated by the nature of the costs and influenced by conflicts of purpose. The result falls short of perfection. Paton and Littleton (An Introduction to Corporate Accounting Standards) observe that, ". . . cost allocation at the best is loaded with assumption and . . . in many cases highly arbitrary methods of apportionment are employed in practice. Certainly it is wise not to take the results of the usual process of internal cost imputation too seriously." Goetz (Management Planning and Control) is highly critical of conventional methods of allocating manufacturing overhead.

Primary Distribution

PRIMARY AND SECONDARY DISTRIBUTION DEFINED. The primary distribution of overhead consists of assigning, allocating, or apportioning the costs, on various bases deemed logical and reasonable, to all the departments, divisions, or cost centers of the factory to which they apply. In making the primary distribution, the distinction between a **producing department, a service department,** and a **nominal department or cost center** is of no consequence.

Secondary cost distribution consists of a redistribution of the total costs of each service department to producing departments and other service departments. Such a distribution constitutes an **indirect** or **redistributed charge** to the department receiving it. There are two basically different procedures followed in making service cost distributions. In some cost accounting systems, **service department costs** are distributed directly and entirely to producing departments only. In other cost accounting systems, part of a service department's costs may be distributed, in certain instances, to other service departments before final redistributions of total costs of service departments are made to the producing departments.

BASIC INFORMATION FOR PRIMARY DISTRIBUTION. Various types of statistical and accounting information must be maintained or developed to provide the bases for certain cost distributions. Typically, the following types of data are needed:

1. Statistical information pertaining to plant layout.
   a. Ground dimensions and acreage.
   b. Roadways, walks, and railroad sidings.
   c. Buildings and dimensions.
   d. Departmental occupancy of buildings.
   e. Floor area of buildings.
   f. Cubic content of buildings.
2. Statistical information relating to machinery and equipment. Location of equipment in departments.
3. Statistical information relating to personnel.
4. Accounting information relating to property.
   a. Plant equipment ledger.
   b. Property insurance register.
   c. Patents register.

The **plant layout** is a blueprint or drawing of the entire ground area occupied by the plant. The boundary lines of the land indicate measurements and acreage owned. Driveways, railroad sidings, walks, storage piles, building foundation

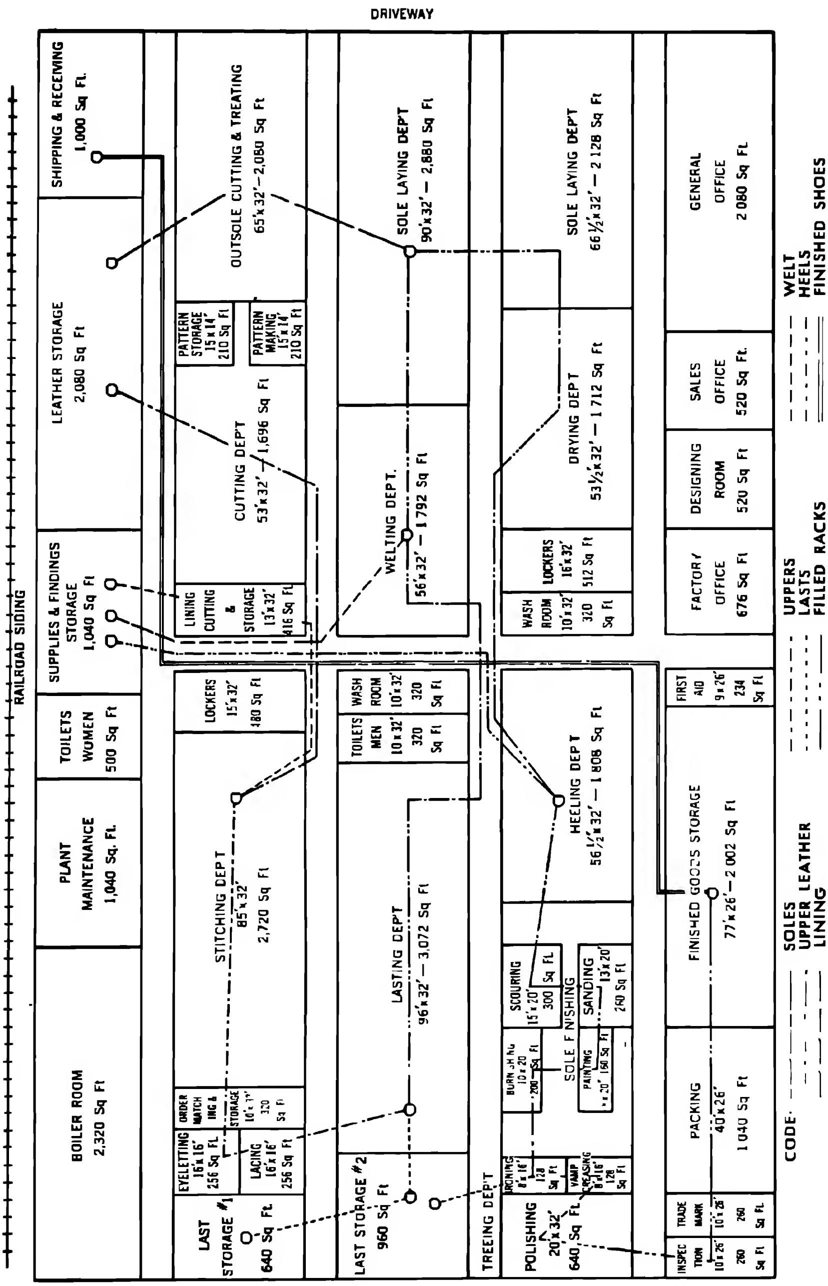


Fig. 1. Plant layout and flow chart.

A. J. de Matteo

lines, and all other pertinent date are shown and drawn to scale. The plant layout also discloses **departmental occupancy** of each building (see Fig. 1). Departments are identified and their dimensions shown. These are useful in making many expense distributions. Departmental **dimensions** on a cubic basis are sometimes required. This may be needed to make the primary distribution of an item such as heating expense.

A **plant and equipment ledger** should provide information on the location and other pertinent data on machinery and equipment. The record classifies, by departments, the location of each unit of machinery and equipment—usually by **code number** and **name.** The purpose of this classification is to enable the cost department to allocate depreciation and property insurance to the proper departments when the primary expense distribution is made.

The **property insurance register** contains a record of policy premiums paid to cover all buildings, machinery, and equipment. From this register the monthly insurance expense can be identified with the property to which it applies.

A **patents register** will reveal the cost of each patent purchased or developed by a company. This record also may disclose the department that should be charged for the periodic patent amortization expense.

Various personnel, timekeeping, and payroll records will provide information as to number and types of employees in the various departments, hours worked, rates of pay, etc. Statistics of this sort provide bases for the distribution of certain types of expenses. An example is workmen's compensation insurance.

ALLOCATION AND PRORATION OF INDIRECT MANUFACTURING COSTS. These can be classified in two ways:

1. Those items which can be identified directly with specific departments Such identification is known as allocation.
2. Certain joint items which must be distributed among two or more departments This process is known as proration.

In practice, the terms **allocation, proration,** and **distribution** are used more or less synonymously.

Direct Allocation of Indirect Manufacturing Costs. The allocation of many of these costs can be accomplished without difficulty at the time the cost is recorded in the original record. The nature or description of the item clearly indicates the department to be charged. Following are a few illustrations of such costs and the original records involved:

Original Record	Example of Cost Allocated to Specific Department
1. Purchase voucher	Coal purchased for powerhouse.
2. Petty cash voucher	Bus fare for clerk in works manager's office.
3. Stores requisition	Small tools, factory supplies, and repair materials for use in specific producing or service departments.
4. Defective work ticket	Spoilage identified with specific producing department where it occurred.
5. Maintenance and repair order	Maintenance and repairs made in a specific producing or service department.

There are many other costs that may be directly allocated on the basis of information provided by various summary records maintained by or available

to the cost accountant. The following are a few examples of such costs and the summary records that provide the information needed for the allocation:

Summary Record	Example of Cost Allocation
1. Departmental classification of machinery and equipment.	Depreciation on machinery and equipment allocated to specific departments where units are located.
2. Departmental identification of patents utilization.	Patents amortization allocated to specific departments.
3. Payroll or indirect labor analysis.	Indirect labor classifications by the nature of their occupations allocated to specific departments.
4. Workmen's compensation insurance cost analysis.	Workmen's compensation insurance cost allocated to departments on basis of indirect labor cost allocation.
5. Social security tax analysis.	Federal and state old age benefit and unemployment compensation insurance costs allocated to departments on basis of direct and indirect labor cost allocation.

Proration of Joint Indirect Manufacturing Costs. Some plant costs are shared jointly by a number of departments. The distribution of such joint costs to the departments affected is known as proration. All costs which cannot be directly allocated to specific departments are prorated among the producing and service departments. Data for **prorations of plant costs** are prepared from summary work sheet analyses. Some examples of the types of analyses and the cost proration involved are as follows:

Analysis	Example of Cost Proration
1. Building depreciation cost analysis.	Depreciation on buildings.
2. Building insurance cost analysis.	Insurance on buildings.
3. Building tax cost analysis.	Taxes on buildings.
4. Building heat cost analysis.	Heat purchased for buildings.
5. Building lighting cost analysis.	Light purchased for buildings.
6. Building maintenance and repairs cost analysis.	Maintenance and repairs on buildings.
7. Machine kilowatt power consumption summary.	Power purchased for machine operation.

The bases most commonly used in prorating costs among producing and service departments are:

1. Floor area.
2. Cubic content.
3. Square feet of radiation.
4. Kilowatt-hours, direct labor hours, machine hours, etc.
5. Number of employees.

Thus such items as building depreciation, building insurance, building maintenance, and even building taxes are quite commonly prorated on a **floor area basis.** Heat, if it is not meter-measured, may be distributed on the basis of the cubic content of the various departments, or the floor area, or the square feet of radiation. Similarly, the cost of lighting may be prorated on the basis of floor area, cubic content, number of outlets, kilowatt-hours, etc.; power may be distributed on the basis of **rated capacities** of machines, machine hours, horsepower hours, or even direct labor hours.

BOOKKEEPING ARRANGEMENTS. The mechanics of recording manufacturing costs and their distribution can follow any of several patterns. Generally, the **control account-subsidiary ledger procedure** is employed. At least one control account, Manufacturing Overhead Control (or other appropriate title), is kept in the general (or factory) ledger. Subsidiary to this will be either individual manufacturing overhead accounts established on a "natural" or "object" classification (for example: Factory Superintendence, Depreciation, and Supplies Expense) or, instead, subsidiary accounts by departments, both producing and service. These departmental accounts usually have a number of columns, one for each type of cost. Accounts of the columnar type are usually called **standing orders.**

If the **object type of subsidiary accounts** is used, the distribution by departments may be recorded on a columnar work sheet, whose totals provide the data for appropriate detailed or summary entries at the end of the period. If the standing-order type of subsidiary ledger is used, the primary distribution is made at the time the costs are recorded.

Numerous variations are possible. For example, if the object-type accounts are used, columns may be provided for departmental distribution at the time the entries are recorded. Lawrence (Cost Accounting, revised by Ruswinckel) suggests that this latter arrangement (a page for each cost and a column for each department) is superior to the opposite arrangement (a page for each department and a column for each cost) because there are usually more costs than departments. Neuner (Cost Accounting) observes that the control account can "control" both the subsidiary object-type ledger and the standing-order subsidiary ledger.

On the general ledger (or factory ledger) level any needed number of accounts (control or otherwise) may be employed. For example, there may be a **summary manufacturing overhead account** for each department, either in addition to or without a summary control account. Costs may first go into the summary account, to be moved later into the departmental overhead accounts (after the standing-order accounts have been completely posted or cost distribution has been completed). Alternatively, there may be a control account over each standing order without using a single summary account.

Primary Distribution of Specific Costs

PRORATION TESTS. A large number of costs commonly found in manufacturing overhead are discussed in the subsequent text. It should be understood that this is not intended as a complete list of all possible items. There is a brief description of the preferred way or ways of prorating each item. It would be inadvisable to say that a particular method should be followed in all cases. The appropriateness of a method will depend to some extent on the conditions in a given plant. When conditions change (as, for example, with the installation of more mechanized procedures), it is advisable to review the method to see if it is still appropriate in view of the changed conditions (NAA Research Series No. 32, Accounting for Labor Costs and Labor Related Costs).

Any base that is chosen for proration purposes should meet two tests; it should be **equitable** and it should be **practicable.** Thus it should result in charges to each department that will be reasonable in view of the benefit the department receives, and it should not be too costly to use. In some cases a much more costly method of proration, perhaps involving the continued collection of data, may

result in a slightly more accurate proration, but the small increase in accuracy may not justify the much greater cost of this method.

BUILDING REPAIRS AND MAINTENANCE. Building repairs and maintenanace cost is accounted for in one of two ways:

1. Actual costs incurred for repairs and maintenance each month are charged to a Building Repairs and Maintenance Cost account which is prorated at the end of each month.
2. A maintenance reserve or allowances account is used.

Building repairs, particularly major repairs occurring irregularly, may cause violent fluctuations in annual maintenance charges. It is often desirable to stabilize these charges by anticipating repairs for a fairly long term and to prorate such estimates to each cost period. This, in effect, converts maintenance into a fixed charge, since a maintenance cost account is debited whether repairs are made or not. The offsetting credit is to an account which in the past has usually been called a **reserve,** such as Reserve for Repairs or Reserve for Nonrecurring Building Expense. In view of the recommendations of the Committee on Terminology of the American Institute of Certified Public Accountants (Accounting Research Bulletin No. 34, reaffirmed in Accounting Terminology Bulletin No. 1) that the term "reserve" should be used only to indicate an undivided portion of assets being held or retained for general or specific purposes, it seems preferable to avoid the use of the term in connection with the equalization account for repairs, and instead to use a term such as **allowance for repairs** (see the Accountants' Handbook, Wixon, ed.). Actual repair costs are debited to this account. The foregoing practice is quite common; for example, steel mills and foundries often show an account "Reserve for Relining of Furnaces," which falls into this group.

Under both plans the departmental distribution of repairs and maintenance cost is often based upon the area occupied by each department in the building, expressed as a percentage of total area.

BURGLAR ALARM SERVICE. The cost of this service may be charged to Building Occupancy (Building Service) to be reallocated in the secondary-distribution process. Vance (Theory and Technique of Cost Accounting) suggests that the cost can be allocated in the primary distribution on the basis of value of property in the various departments, or on the basis of the number of alarm devices.

DEPRECIATION, INSURANCE, AND TAXES. These costs are collected from records under the control of the following **general ledger accounts:**

1. Accumulated Depreciation, or Allowance for Depreciation (formerly Reserve for Depreciation).
2. Prepaid Insurance.
3. Prepaid or Accrued Taxes.

Periodic fixed charges emanating from the above accounts are analyzed and charged departmentally under the proper cost classification. **Registers** of property and plant, insurance, and taxes are maintained in most factories. These records are designed to provide a detailed analysis of the fixed charges each month.

Building Depreciation Cost. A **property ledger** is used to classify plant investment by type of land, buildings, and equipment. This record should show location and cost, with accumulated depreciation in the case of buildings and

equipment. The proration of depreciation on buildings to departments is based upon three factors:

1. Cost of building.
2. Total area of building.
3. Area occupied by each department in building. (This is usually reduced to a percentage of the total area.)

The cost of the building is obtained from a **factory building and equipment ledger**. The total area of each building, and also the area of each department within a given building, is obtained from a record or plant layout showing departmental occupancy of bulidings. From these data a **work-sheet analysis** of building depreciation is obtained. This analysis provides the total depreciation charge for each building and the proration, where necessary, to departments within each building. (A detailed discussion of alternative methods of calculating and accounting for depreciation may be found in the Accountants' Handbook, Wixon, ed.)

Depreciation on land improvements and buildings, applicable to a **power plant**, should be segregated from depreciation applicable to all other land improvements and buildings. The former is charged specifically to the power department, while depreciation applicable to other land improvements and buildings is included with other costs to be prorated departmentally on a floor-area basis.

Depreciation on Factory Machinery and Equipment. Distribution of depreciation on machinery and equipment is made to the different departments, based upon the following three factors:

1. Cost of each unit of factory equipment.
2. Rate of depreciation applicable to each unit of equipment.
3. Departmental location of each unit.

All this information may be provided by the **factory equipment ledger**. A work-sheet analysis of machinery and equipment depreciation is prepared which, in turn, provides the information for the departmental expense distribution sheet.

Insurance. Insurance cost consists of several types of coverages against losses from differing causes. The accounts differentiate fire insurance on buildings, machinery and equipment, stores, goods in process, and finished goods. With the exception of fire insurance on buildings, this cost is charged departmentally on the basis of the insurable value in each department.

Fire insurance on land improvements and buildings applicable to the **power plant** should be segregated from fire insurance applicable to all other land improvements and buildings. The former is charged specifically to the power department, while fire insurance applicable to other land improvements and buildings is included with other costs to be prorated departmentally on a floor area or some other equitable basis.

Boiler explosion insurance should be prorated to all production departments using pressure vessels, as well as to the power department.

Fidelity insurance should be charged to those departments whose employees are bonded.

Payroll robbery insurance should be charged to the payroll department.

Automobile insurance should be charged according to specific coverages.

Tornado, use and occupancy, plant explosion, riot and civil commotion, and elevator insurance cost should be collected with all other costs to be prorated on a **floor-space basis** and spread to all departments.

Indirect Labor Account		Grand				Departments						
Code	Name	Total	90	91	92	93	01	02	03	04	05	06
508	Repair Labor.	$ 9,000.00	$ 4,850.00	$ 250.00	$ 250.00	$ 500.00		$ 2,050.00				$ 1,100.00
512	Materials Handlers.											
513	Helpers											
514	Service Attendants											
530	Foremen.											
531	Department Heads											
532	Shop Office Clerks											
	Total Indirect Labor . .	$ 53,980.00	$12,350.00	$ 4,490.00	$ 3,370 00	$ 4,540.00	$ 5,100.00	$ 4,530.00	$ 5,800.00	$ 3,400.00	$ 3,200.00	$ 7,200.00
	Total Direct Labor . . .	149,800.00	40,000.00	75,000.00	10,800 00	24,000 00						
	Total Labor	$203,780.00	$52,350.00	$79,490.00	$14,170 00	$28,540.00	$ 5,100.00	$ 4,530.00	$ 5,800.00	$ 3,400.00	$ 3,200.00	$ 7,200.00
	Workmen's Compensation Insurance Rates		5%	4%	6%	3%	3%	4%	3%	1%	1%	3%
	Estimated Workmen's Compensation Insurance Cost	$ 8,293.70	$ 2,617.50	$ 3,179.60	$ 850.20	$ 856.20	$ 153.00	$ 181.20	$ 174.00	$ 34.00	$ 32.00	$ 216.00

NOTE: Detailed figures purposely omitted.

Fig 2. Work-sheet analysis of workmen's compensation insurance

Workmen's Compensation Insurance. Workmen's compensation and liability insurance cost should be accrued periodically Distribution of these items is based upon total factory labor, which includes both direct and indirect labor Compensation insurance usually is computed by applying the policy rates for the various labor operations and occupations to the current month's payroll analysis The occupational labor hazard and casualty record for each labor operation or occupation determines the rates established by the insurance company Each month a work-sheet analysis of labor by departments, similar to Fig 2, is prepared in order to provide a basis for the computation of workmen's compensation insurance

Insurance on Machinery and Equipment. Distribution of the cost of insurance on machinery and equipment is made among various departments, based upon the following factors

1 Premium cost
2 Valuation by departments
3 Analysis of equipment valuation according to various insurance premium rates

The monthly insurance premium cost on machinery is obtained from a work-sheet analysis prepared from the insurance register The original cost of different units of machinery and equipment is obtained from the factory equipment ledger sheets From these ledger sheets a departmental analysis is made of the premium rates Fig 3 shows a portion of the departmental proration of insurance on machinery and equipment

Building Insurance Cost The basis for proration of building insurance cost is obtained from the following sources

1 Building insurance premium
2 Total area of building
3 Area occupied by each department in building reduced to a percentage of the total

The monthly premium cost is obtained from a work-sheet analysis prepared from the insurance register The distribution is similar to that for depreciation on buildings

Taxes, Real and Personal. Taxes on buildings are segregated from those on personal property Any special taxes levied by county authorities, such as automobile taxes, are charged specifically Taxes on land improvements and buildings, applicable to the **power plant,** are segregated from other taxes by being charged specifically to the power department, while taxes applicable to other **land improvements** and **buildings** are included with other costs to be prorated departmentally on a floor area or other convenient basis

Taxes on personal property should be prorated departmentally on the basis of the taxable values in each department

For the Year 19___

Department	Original Cost Value	Percentage	Property Insurance Rate per Annum: $5.00 per Thousand	Property Insurance Rate per Annum: $3.00 per Thousand	Monthly Charge
90	$1,800,000	60%	$ 9,000		$ 750
91					
92					
93	[Detailed figures purposely omitted.]				
02					
03					
06					
	$3,000,000	100%	$15,000		$1,250
01	$ 24,000	50%		$ 72.00	$ 6
03					
04					
05					
	$ 48,000	100%		$144 00	$ 12
Total Machinery and Equipment Insurance Expense					$1,262

Fig. 3. Departmental analysis of insurance on machinery and equipment.

The total tax on machinery and equipment should be charged to the individual departments according to the percentage relationship of machinery and equipment values in each of the departments.

The total tax on raw materials and stores should be charged to the stores department.

The total tax on **goods in process** should be charged to departments on the basis of the value of unfinished goods in each department at the beginning of the year.

The total tax on finished merchandise should be charged to the finished goods warehouse department.

The accounting for real and personal property taxes raises two questions on which there have been diverse opinions: (1) when should these taxes be recorded on the books of a taxpayer keeping his accounts on the **accrual basis,** and (2) what is the amount of tax that should be charged against the income of each fiscal period. The AICPA Committee on Accounting Procedure (Accounting Research Bulletin No. 43) reports that in practice these taxes have been charged against the income of various periods. It points out the need for individual judgment and the importance of consistency of application from year to year and states, "Generally, the most acceptable basis of providing for property taxes is monthly accrual on the taxpayer's books during the fiscal period of the taxing authority for which the taxes are levied. The books will then show, at any closing date, the appropriate accrual or prepayment."

Building Taxes. Distribution of building taxes depends on the **area** occupied by each department in a building, reduced to a percentage of total. This is in contrast to personal property taxes, which are usually distributed on a **valuation basis.** Other bases are possible, of course. Where real property taxes are prepaid, the amount applicable to a given year is available from a Prepaid Property Taxes account. If property taxes are due sometime after the beginning of the fiscal year, the amount of taxes applicable to the fiscal year must be estimated. In the latter case, the **annual estimate** is used in computing the proration of building taxes expense. If land taxes are assessed separately from building taxes, it is necessary to prorate land taxes applicable to factory buildings in proportion to the area occupied by the buildings. Distribution of building taxes is similar to the computations made for other costs handled on an area basis.

Social Security Taxes. Distribution of this cost item can be computed from the same **labor work-sheet analysis** used to compute workmen's compensation insurance (Fig. 2).

The payroll tax rates applicable for a given year are multiplied by the departmental labor distribution totals in order to arrive at the allocation of departmental cost for social security taxes. Assuming rates of 2½ percent for the Federal Insurance Contributions Act tax, 3/10 percent for the Federal Unemployment Insurance tax, and 2.7 percent for the State Unemployment Insurance Tax, the allocation appears as follows:

Department	Payroll (Fig. 2)	Social Security Tax at 5½%
90	$ 52,350.00	$ 2,879.25
91	79,490.00	4,371.95
92	14,170.00	779.35
93	28,540.00	1,569.70
01	5,100.00	280.50
02	4,530.00	249.15
03	5,800.00	319.00
04	3,400.00	187.00
05	3,200 00	176.00
06	7,200.00	396.00
	$203,780 00	$11,207.90

The computation is not so simple as indicated when the gross earnings of some employees reach the limit of the amounts subject to the various taxes. (See section on Labor Costs for a discussion of social security taxes.)

FACTORY OFFICE SUPPLIES. There are two ways to account for this item of cost:

1. All purchases of factory office supplies are charged to an inventory account when purchased. When supplies are needed, they are requisitioned and charged to the requisitioning department.
2. All purchases of factory office supplies are charged as a cost directly to the department for whom the purchase was made.

FACTORY SUPPLIES AND INDIRECT MATERIALS. These include the cost of all materials and supplies that either do not form part of, or cannot be conveniently applied directly to, any article produced. The primary cost distribution of factory supplies is made on the basis of an analysis and summary of the **stores requisitions** that show the departments to which the supplies were issued.

FUEL COST. The purchase of fuel may be accounted for by charging the cost either to an **inventory account** or directly to a **cost account.** Under the former plan allocation of fuel cost to departments is based upon the quantities consumed by each department using fuel. Quantities used are measured by actually weighing the issues (coal and coke), by the meter measurement of the consumption (fuel oil, gasoline, kerosene, and gas), or by merely estimating the issues. Where fuel is charged to cost at time of purchase, the departmental allocation will be indicated on the **purchase voucher.**

GENERAL FACTORY COST. Most costs can be identified with a functional division or department. Regardless of how finely a plant is departmentalized, however, costs arise which are general to all departments of a plant. In order to collect these costs, a department or cost-center account entitled General Factory Cost or Factory Service is used.

HAULING WASTE. The cost of hauling off or otherwise disposing of waste may be charged either directly to the department producing the waste or to Building Occupancy (Building Service) or General Factory Cost.

INDIRECT LABOR. In the broadest sense indirect labor refers to labor cost that cannot be specifically or directly associated with jobs or products. In some account classifications, however, the term is given a narrower meaning. For example, in the MAPI Accounting Manual (Machinery and Allied Products Institute) the account for Indirect Labor is to be used for "Hourly wages paid for work that is of a service nature to productive operations, such as internal transportation, maintenance, sweeping and cleaning, watching and guarding, storeroom attendants, etc." Charges for the compensation of supervisory personnel and for certain types of clerical labor are to be accumulated in accounts with more specific designations. (For a detailed discussion of indirect labor, see section on Labor Costs.)

The distribution of indirect labor cost (however defined) is obtained from an **indirect labor or payroll distribution sheet.** These records can be designed to provide departmental totals of various kinds of indirect labor.

INTEREST ON INVESTMENT. Whether imputed or implicit interest on investment should be considered as a cost of manufacture is an unsettled question. (For a discussion of the subject, see the section on Accumulation of Manufacturing Overhead.) If such interest is to be included, the charge for interest on building investment would be prorated on the basis of space occupancy, and the charge for interest on investment in machinery and equipment on the basis of the location of these assets.

MEDICAL SERVICE COST. Where services of a physician and surgeon are paid for on a monthly retainer-fee basis, the primary distribution is usually charged directly to a general service department account, or to the Hospital and Medical Care Department where there is one. Through a secondary distribution the total cost of this activity is prorated to other departments on one of the following bases:

1. Departmental casualty record.
2. Number of workmen employed in each department.
3. Departmental labor cost analysis.

The **department casualty record** is probably the best of the three bases to use because it prorates medical service expense in proportion to the number of casualties in each department. The number of workmen employed in each department, when used as a basis for prorating medical services expense, is not as

equitable as the first. The expense in this case is prorated on a standing or ready-to-serve basis rather than upon an actual experience basis. The departmental labor cost analysis has little merit as a basis for prorating medical expense. The usual explanation is that the departmental labor cost analysis must be obtained for other purposes, and therefore it is available as a basis for prorating medical service cost. There is usually no definite relationship between labor cost of each department and departmental casualties. Where both medical examinations and hospital care are provided, a combination basis may be used. The number of employees may be weighted by the **casualty-record factor to** provide an equitable distribution.

PATENT AMORTIZATION COST. Allocation of patent amortization cost depends upon the location of **patent utilization.** As patent costs are capitalized, a record is made of the department in which the patent is to be used. From this record a monthly work-sheet analysis is prepared for the expense distribution. (See also the discussion under Research and Development in this section.)

PURCHASED POWER COST. The cost of purchased power can be prorated on the basis of **meter records** of consumption or, lacking meters, on the basis of **rated capacity** of equipment times hours of use. If a record of the use of equipment is not maintained, the distribution may be made solely on the basis of the rated capacity of the equipment. In some cases the use of **portable meters** in each department for limited periods is an economical method of obtaining an equitable basis for prorating power costs.

Schlatter and Schlatter (Cost Accounting) recommend a two-step method for the allocation of purchased power cost where there is a **minimum charge** regardless of the quantity consumed and the consumption in a particular period is so low as to cause the minimum to be the charge. Under these circumstances the proration of the cost is calculated as follows:

> Each department is assigned a charge based on the unit rate per kilowatt-hour times the kilowatt-hours of consumption in the department. If the total amount is equal to, or in excess of, the minimum, there is no problem. If, however, the aggregate is less than the minimum, the amount of such deficiency should be prorated to the several departments in the ratio of their failure to consume their shares for the minimum charge.

For example, suppose Departments A, B, and C have the capacities to use purchased power as follows: A, 4,000; B, 8,000; C, 12,000; this is 1:2:3 ratio. The cost of power is 2 cents per kilowatt-hour, with a minimum charge of $300 per month. This means that 15,000 units ($300 ÷ $0.02) must be paid for whether used or not. The minimum is ⅝ of total capacity (15,000 ÷ 24,000) and therefore each department's share of the minimum is: A, 2,500; B, 5,000; C, 7,500.

Suppose that the actual consumption in a particular month for A, B, and C was, respectively, 1,500, 5,000, and 7,500—a total of 14,000. At 2 cents per unit, this would amount to $280. The total charge, however, is $300 (the minimum). The proration of the $300 expense would be as follows:

	Department		
	A	**B**	**C**
Step 1. Actual consumption × $0.02	$30	$100	$150
Step 2. Since only Department A failed to use its share of the minimum, it must bear the deficiency	20		
Total	$50	$100	$150

Goetz (Management Planning and Control) states that a typical industrial rate for electric power is composed of four separate charges: (1) a **kilowatt-hour charge,** (2) a **demand charge** based on maximum power used in any 15-minute period during the preceding 12 months; (3) a **peak charge** based on maximum power used in any 15-minute period between 4:30 and 6:00 P.M. on any day during the preceding 12 months; and (4) a penalty for **low power factor.** Some companies make special arrangements, including changes in production schedules and in hours of work in certain departments, to keep the demand charge and the peak charge as low as possible. Goetz advocates a careful study of the conditions in each plant so that each of these four charges may be distributed in accordance with the factors which actually cause the incurrence of the charge.

RELINING COST. This item is allocated to the department where the furnaces are located. The estimated relining cost is based upon past experience. The life of the lining after installation and the past average actual cost are the two factors considered in estimating the monthly cost total. Where possible the life of the lining is estimated in terms of units of product, and the **monthly charge** is calculated as in the following example:

1. Total estimated relining cost	$ 5,000 00
2. Number of tons processed before new lining is necessary	50,000 00
3. Cost per processed ton (line 1 ÷ line 2)	$ .10
4. Production for January	500 tons
5. Charge to January operations (line 3 × line 4)	$ 50 00

ROYALTIES. Royalties paid on the basis of units produced or for the use of a machine or a process, whether based upon units produced or as a fixed monthly or annual rental, are a manufacturing cost, but where royalty payments are based upon units sold, they are commonly treated as either a selling or a general expense. If the royalty is based upon the number of units produced, it may be considered a direct charge to production rather than an element of overhead to be distributed. If the royalty takes the form of a flat charge per month for the right to use a process or machine, the cost should be assigned to the department wherein the processing is performed or the machine is located.

SMALL TOOLS COST. Three basically different methods are used to allocate the cost of small tools. At the time of purchase, such tools may be: (1) capitalized in a Small Tools account, (2) charged to Stores, or (3) charged to expenses.

Capitalization Method. All purchases of small tools are capitalized in a Small Tools account, which is considered a fixed asset. **Depreciation** is applied in order to establish annual and monthly amounts to charge off as expense. This is a difficult method to administer properly because of the variation in, and the uncertainty of, the length of life of many different small tools. Under this method the monthly allocation of small tools cost is similar to that used for depreciation of machinery and equipment.

A variation of this method is to capitalize tool purchases, but in lieu of measuring depreciation, to revalue them at the end of each period. The sum of the beginning tools inventory plus the cost of the tools purchased during the period, minus the inventory of the tools at the end of the period, would give the cost of the tools to be charged to the operations of the period.

Charging Stores. All small tool purchases are charged to stores inventory. As tools are needed, they are requisitioned and charged to the proper department. Analysis of the requisitions provides a means of allocating the cost to departments.

Charging Expense. Small tool purchases are charged to expense at the time of purchase. This method is popular because of its simplicity. Analysis is made of all **purchase vouchers** which indicate a charge to the account for Small Tools in order to allocate the charges to the several departments.

Charges for Patterns, Tools, and Dies. Where patterns, special tools, or dies are made for a special job, the entire cost is chargeable to the job. Where patterns, tools, and dies are expected to be used for a considerable number of months or years, their cost is capitalized and depreciated as in the case of other equipment and machinery.

COST OF SPOILED WORK. The treatment of the cost arising from spoilage depends upon several factors such as whether the amount of spoilage is deemed abnormal or not, the nature of the jobs or processes wherein the spoilage occurred, and the relative amount of recovery from the disposition of spoiled materials (see section on Materials). If the cost is to be treated as **overhead** (in contrast to absorbing it as a cost of a particular job or process, or to treating it as a special expense or loss to be separately reported in the income statement), it may be assigned to the department in which the spoilage occurred or charged to General Factory Cost. The latter treatment will result in the item's being spread to most of or all the departments in the redistribution process.

TELEPHONE COST. If a record of telephone calls by departments is kept, telephone cost can be distributed with considerable accuracy. In many cases it is only the cost of long distance calls that can be identified on a departmental basis The basic monthly charge and/or additional charges for local service can be prorated on the basis of the number of telephone instruments in the several departments or on a basis resulting from a special study of telephone use.

TELEGRAPH COST. If telegraph charges are of sufficient amount to warrant analysis and distribution to departments, the records that arise from using this means of communication (copies of messages, monthly statement from the telegraph company, etc.) provide the information for assigning this cost to the several departments.

WATER COST. Where water is purchased from a public utility company, the statement rendered is based on meter readings in the majority of cases. If bills are rendered only quarterly, however, the monthly cost must be estimated. The schedule of rates provided by the utility company can be used to ascertain the estimated water cost. The computation of water cost and its allocation to departments may be illustrated as follows:

Department Number	Name	Meter Readings: Beginning of Month	Meter Readings: End of Month	Gallons Consumed	Estimated Cost
92	Heat Treating	867,000	899,269	32,269	$ 36.00
05	General Plant	1,916,000	1,960,819	44,819	50.00
06	Powerhouse	27,100,000	27,368,912	268,912	300.00
	Total gallons consumed			346,000	$386.00

Public Utility Company Rate Schedule:

First	10,000 gallons @ $3 per thousand	$ 30.00
Next	20,000 gallons @ $2 per thousand	40.00
Next	316,000 gallons @ $1 per thousand	316.00
	Total estimated water expense	$386.00

Cost per 1,000 gallons = $386/346 = $1.115607.

The unit cost of $1.115607 forms the basis for **departmental charges.** The gallons consumed in each department are multiplied by the unit cost. The result appears in the last column of the above table headed "Estimated Cost." If the water used by each department is not metered, the cost must be prorated on the basis of estimates of the proportions of total consumption.

Secondary Distribution

NATURE AND PURPOSE OF SECONDARY DISTRIBUTION. The primary distribution of factory overhead allocates or apportions all the costs to the several departments and cost centers of the factory. In making this distribution, the distinction between production and service departments is of no concern. Since one of the purposes of overhead distribution is to make it possible to assign overhead by departments to the products in a reasonable manner, however, it is necessary to gather all the factory overhead by producing departments or cost centers. The allocation or redistribution of the costs originally assigned to the service departments or centers (real or nominal) to the producing departments or centers is termed "secondary distribution."

BASES FOR SECONDARY DISTRIBUTIONS. The two major bases or philosophies of allocating service department costs to producing departments are: (1) on the basis of service rendered and (2) on the basis of readiness to serve.

Distribution on the Basis of Service Received. Distributing service department costs to producing departments on the basis of the relative amounts of benefits actually obtained from a service department has the appeal of simple logic. If, for example, the medical department or first aid station treated twice as many employees of one producing department as those of another, it seems reasonable that the relative shares of the medical department's costs should be borne in a 2:1 ratio by the two producing departments in the example.

Distribution on the Basis of Readiness to Serve. In spite of the simple logic and apparent equity of prorating the costs of a service department on the basis of the relative amounts of service rendered to other departments, such a basis may be unreasonable, or even unworkable in some cases. In appraising this basis, Lang–McFarland–Schiff (Cost Accounting) raise the question in connection with the medical cost example as to whether the basis should be number of accidents or seriousness of accidents, and if the latter, how the degree of severity should be measured. Suppose further that in a certain month one department had no accidents, employed and discharged no personnel, and had no machine breakdowns. A pure service-received basis of secondary cost distribution would cause the department in the example to receive no share of the cost of the medical department, the personnel department, and the repair shop. Such a result does not seem entirely reasonable.

Service departments must have a certain capacity in order to perform their particular function. The capacity is determined by the demands that may be made upon them by the other departments. The cost of maintaining this **capacity to serve** may be legitimately apportioned among the other departments in the ratio of their ability or **capacity to use** the benefits or products of the service department. It may be that all the costs of a service department can be assigned in the proportion of the using departments' capacity to consume the service. When justified on principle, the method often has the virtue of simplicity and economy, since approximations of relative ability to consume may be easier to

obtain than measures of "actual" consumption. In some cases a **dual allocation basis** may be required. This procedure (described in more detail under Combination or Dual Basis of Distribution in this section) attempts to make the distribution in a way that takes into consideration both readiness to serve and service rendered.

Other Bases for Secondary Distribution. Blocker and Weltmer (Cost Accounting) mention four methods of apportioning overhead costs: (1) service or use, (2) analysis or survey of existing conditions, (3) ability to pay, and (4) efficiency or incentives. The first method has already been considered. The **analysis or survey of existing conditions** is used in cases where a basis of distribution is difficult to select. One example is the case of elevator cost where the distribution could be based upon a survey of who uses the elevators during typical hours and days.

The **ability to pay basis**, as applied to a factory, involves the assignment of larger shares of the costs of service departments to those producing departments whose product is considered to contribute the most to the income of the enterprise. The weaknesses of this method, from both the standpoints of measuring efficiency and of equity, are apparent.

The **efficiency or incentives method** involves the use of standards, budgets, and quotas. The distribution is on the basis of a pre-set budget or standard. Excessive overhead is transferred to Profit and Loss and thus does not become incorporated in the cost of production.

In choosing the bases of distribution for the costs of service departments, the **practicability** and **economy** of the various methods must be considered as well as their theoretical virtues. Simplicity, which usually means economy, of method must be weighed in reaching the decisions.

SUPPLEMENTARY OVERHEAD RATES FOR SERVICE DEPARTMENTS. Neuner (Cost Accounting) states that some firms do not close service-department overhead accounts into the producing-department overhead accounts. "Instead, a separate or supplementary overhead rate is calculated for each service department, and this rate is used on the cost sheets as an additional departmental charge in the same manner as the applied overhead cost for each producing department." It is pointed out that this procedure has not found wide application because its use may not result in any better product costing than the more usual method of assigning the overhead of service departments to producing departments so that it becomes a part of the overhead rates of producing departments.

COMBINATION OR DUAL BASIS OF DISTRIBUTION. In view of the inequity that may result from the distribution of the costs of service departments on the simple basis of service rendered, and the difficulty of even using this principle in some situations, a combination or dual base may be used. The duality involves the assignment of the **fixed costs** of the service department proportional to the relative capacities of other departments to use the service in question and the assignment of the **variable costs** of the service department proportional to the relative amounts of the services actually consumed by other departments.

Schlatter and Schlatter (Cost Accounting) maintain that this dual basis is needed to get the "correct" result, unless the consuming departments always use the service in the ratio of their capacities to consume it—a condition that is not likely to be found in many cases. It is contended that the amount of the fixed

costs of a service department depends upon the amount of the investment in the department. This, in turn, depends upon the size and capacity of the service department. **Size and capacity** is, or was, determined by the capacities of other departments to consume the service. Thus the amount of the fixed costs of a service department is directly related to the capacities of other departments to consume the service. Accordingly the **fixed** service-department costs should be divided among the consuming departments in the ratio of their capacities to consume, regardless of their actual consumption. The logic of assigning service-department **variable** costs on the basis of the actual consumption of the service is self-evident.

The case of a power department is used as an example. If all the power produced is used by two producing departments, whose capacity to consume is in a ratio of 2:1, the fixed costs of the power department are divided between the two producing departments in this 2:1 ratio as long as their relative consumption capacities remain unchanged. Variable costs are apportioned in the ratio of actual consumption in each period. Whenever the consumption, whether large or small, is in the 2:1 proportion, the allocation of the power department cost would be the same under either the simple service-received basis of distribution or the dual basis. If the consumption is in some other ratio, while the capacities to consume are unchanged, the dual basis will give a different (and, it is claimed, better) distribution than the single, service-received basis.

DISTRIBUTING SERVICE DEPARTMENT COSTS DIRECTLY. Under this plan, service department costs are not distributed to other service departments, even though the services provided by certain service departments are utilized by other service departments. Instead, the entire amount of the cost of operating every service department is distributed directly to the producing departments. This plan provides the simplest and quickest method for distributing costs of service departments. The number of secondary cost distributions, under this plan, is equal to the number of service departments. There is accordingly a saving of time and effort in contrast to alternative procedures.

Some cost accountants are of the opinion that more reliable costing results from minimizing distributions. The **objections to elaborate distributions** may be summarized as follows:

1. Service costs are an unavoidable evil, and the easiest method of distribution is the best.
2. Accuracy of job and product costs is not enhanced by elaborate methods of secondary distribution.
3. A more confused mixture of costs results from interdepartmental distributions.
4. For control purposes, knowing the amount of service department costs is sufficient.

Heiser (Budgeting—Principles and Practice) makes the general observation, "There is a growing trend in cost accounting to avoid elaborate and complicated redistribution of service department costs on an interim periodic basis."

Under the plan of distributing service-department costs directly to producing departments, the order in which the service-department cost columns are arranged on a **cost distribution sheet** is of no consequence.

Fig. 4 illustrates a portion of a cost distribution sheet showing secondary distributions of service-department costs direct to producing departments. The totals that result from the primary distribution are shown on the first line. The power-house cost was first analyzed to determine how much was to be associated with

Distribution of Service Department Costs — For January, 19__

Expense Account			Producing Departments					Service Departments						
Code	Name	Grand Total	90 Machine Shop	91 Finishing	92 Heat Treating	93 Assembly	Subtotal	01 Production Planning & Control	02 Toolroom	03 Storeroom	04 Factory Accounting	05 General Plant	06 Power-house	Subtotal
	Total Direct Costs.....	$77,911.71	$29,167.67	$ 8,859.80	$ 7,744.70	$ 5,039.54	$50,811.71	$ 3,300.00	$ 3,700.00	$ 3,800.00	$ 2,100.00	$ 2,200.00	$12,000.00	$27,100.00
	Service Department Cost Distributions:													
5506-1	Heat................		$ 1,095.61	$ 288.32	$ 211.43	$ 326.76	$ 1,922.12						$ 1,922.12	
5506-2	Light...............		410.31	107.98	79.18	122.37	719.84						719.84	
5506-3	Power...............		7,112.11	935.80	1,122.97	187.16	9,358.04						9,358.04	
													$12,000.00	
5505	General Plant........		682.00	836.00	198.00	484.00	2,200.00					$ 2,200.00		
5504	Factory Accounting...		651.00	798.00	189.00	462.00	2,100.00				$ 2,100.00			
5503	Storeroom...........		2,280.00	380.00	228.00	912.00	3,800.00			$ 3,800.00				
5502	Toolroom...........		1,036.00	1,554.00	296.00	814.00	3,700.00		$ 3,700.00					
5501	Production Planning & Control..........		1,650.00	825.00	330.00	495.00	3,300.00	$ 3,300.00						
	Total Service Cost Distributions		$14,917.03	$ 5,725.10	$ 2,654.58	$ 3,803.29	$27,100.00							
	Total Direct and Indirect Producing Departments Costs		$44,084.70	$14,584.90	$10,399.28	$ 8,842.83	$77,911.71							

Fig. 4. Service department cost distributions made to producing departments only.

the production of heat, light, and power. (These computations appear under Secondary Distributions on Nonreciprocal Basis in this section.) **Heat** cost was distributed among the producing departments on the basis of the cubic content of each department, cost of **lighting** on the basis of floor area, and **power** cost on the basis of the consumption by producing departments, as measured by meters. **General plant** cost and **factory accounting** were allocated on the basis of the relative number of man hours in each producing department. **Storesroom** cost was allocated on the basis of the cost of stores requisitioned by the producing departments. **Toolroom** cost was apportioned on the basis of direct labor hours in the producing departments, and **production planning control** cost on the basis of the number of items specified on production orders.

SECONDARY DISTRIBUTIONS ON NONRECIPROCAL BASIS. This is a plan that takes cognizance of the fact that services provided by certain service departments are utilized in part by certain other service departments. The secondary distributions are made accordingly. Under the nonreciprocal basis there is no two-way distribution of costs between two service departments. This means, for example, that a portion of power plant cost may be distributed to the toolroom because the power plant provides a service to the toolroom. No part of toolroom cost is distributed to the power plant, however, even though the toolroom actually rendered some service to it. In deciding the **order of distribution** of service-department costs, the general rule is to distribute first the cost of the service department that serves the largest number of other departments; then the one that serves the next largest number, etc. In the illustration given here, the order of distribution was determined to be: powerhouse, general plant, factory accounting, storesroom, toolroom, and production planning and control.

Matz–Curry–Frank (Cost Accounting) state that when serviceability cannot be measured accurately, the department with the largest total cost should be distributed first, the one with the next largest total second, etc. It is reasoned that the greatest amount of cost indicates the largest amount of service provided. This would not necessarily mean, however, that the departments with the largest amounts of cost necessarily serve more of the other service departments.

There are two principal arguments for allocating service department costs to other service departments as well as to producing departments:

1. Failure to charge a given service department with the cost of services rendered by other service departments causes an understatement of the cost of operating the department receiving the service.
2. If the costs of a service department are controlled through the use of a budget, the cost of services rendered to it by other service departments should be incorporated in the budget. Only by so doing can the efficiency of operation of a particular service department be measured.

The principal arguments against this plan are that a greater amount of work is entailed in its use and that no increase in reliability of costs is secured.

Secondary distribution on a nonreciprocal basis is illustrated in the subsequent paragraphs. The distributions in work-sheet form are shown on page 8·28.

Cost of Steam Produced. The number of thousands of pounds of steam produced during the month is determined from readings of meters that measure the flow of steam to the building heating lines, to steam power turbines, etc. Readings of all meters are taken at the end of each month. The total of costs incurred in steam production for the month is divided by the number of thousands of pounds

of steam produced that month to give a unit cost per 1,000 pounds of steam. The steam consumption of building heat lines, etc., is then multiplied by the unit cost to determine the steam cost for these purposes. In order to determine the cost of steam produced, the costs of the **powerhouse** must be allocated between the **boiler room** and the **engine room.** The analysis may take the following form:

Account Number	Name	Total Cost	Boiler Room	Engine Room
501	Factory Supplies			
502	Small Tools			
504	Fuel			
505	Water			
507	Repair Materials			
508	Repair Labor			
510	Workmen's Compensation Insurance	(Detailed figures omitted.)		
511	Social Security Taxes			
514	Service Attendants			
531	Departmental Heads and Assistants			
552	Depreciation, Buildings			
553	Depreciation, Equipment			
554	Insurance, Buildings			
555	Insurance, Equipment			
556	Taxes, Building			
557	Maintenance, Buildings			
	Totals	$12,000.00	$7,777.00	$4,223.00

With the information in the work sheet and the meter readings, the total pounds of steam produced can be determined, the cost per pound computed, and the boiler room cost apportioned between heat and the production of electric power:

	Meter Readings: Steam Heat Line	Meter Readings: Power Line	
End of this month	91,199 60	76,084.90	
End of last month	84,671 00	56,198.41	
Pounds of steam produced	6,528 60	19,886.49	26,415.09
Boiler room expense			$7,777.00
Cost per 1,000 lb. of steam	($7,777.00 ÷	26,415.09) =	$0.294415
Allocation of steam expense to:			
Steam heat	$1,922.12		
Electric power		$5,854.88	$7,777.00

Steam Heat Cost. The cost of steam measured to the building heat lines is distributed in turn to various departments utilizing heat, on one of the following bases:

1. Cubic content.
2. Radiation surface.
3. Area basis.

Where there is a considerable discrepancy in the **height of ceilings** in various departments, the cubic-content basis is best. Where the height of ceilings is uniform, methods 1 and 3 yield the same result. Since area is easier to calculate, it is preferable. If the heat charge is distributed on the basis of the square feet of radiation, the result approximates method 1, since engineers take into account the height of the ceiling, etc., in prescribing the sizes of radiators to be installed. In this illustration, the total cost of steam heat is distributed on the basis of the **cubic content** of all the departments, exclusive of the powerhouse, since it is assumed that the steam heat is produced by the powerhouse.

Department	Cubic Content	Percent of Total *	Distribution
90	1,600,000	44	$ 845.73
91	416,000	12	230.65
92	320,000	9	172.99
93	480,000	13	249.88
01	256,000	7	134.55
02	128,000	3	57.67
03	315,000	9	172.99
04	70,000	2	38.44
05	42,000	1	19.22
	3,627,000	100	$1,922.12

* Rounded for illustration.

Cost of Electric Power Generated. The cost of electric power generated consists of the total of the engine room costs plus a share of the boiler room costs. In the present illustration the cost of power generated is computed as follows:

Total expenses of generating electric power exclusive of cost of steam....	$ 4,223 00
Total cost of steam allocated to generation of electric power............	5,854.88
Total cost of electric power generated	$10,077.88
Total kw-h. of electric power generated..............................	560,000
Cost per kw-h. ($10,077.88 ÷ 560,000)................................	$ .017996

The electric energy produced is distributed each month to two separate lines, as follows:

1. Power circuit for machinery and equipment.
2. Lighting circuit for buildings and yard.

The distribution takes place on the basis of **meter readings** as follows:

Allocation of electric power generated to:

Building light circuit	40,000 kw-h. @	$.017996	$ 719.84
Machinery power circuit	520,000 kw-h. @	.017996	9,358.04
Total power cost	560,000 kw-h. @	.017996	$10,077.88

Electric Light Cost. The lighting circuit for an entire building is usually on a single meter, so that total kilowatt-hour consumption for lighting can be definitely measured each month. **Departmental distribution** may be made on the following bases:

1. Departmental floor area.
2. Engineering estimates.
3. Number of outlets.

The area basis provides a very simple method for the distribution of the cost of electric light, but it may result in inaccurate and inequitable charges to different departments. Departments which have ample skylights and large side windows do not need so much electric light as departments which do not have as much natural light. The limitation of the area basis is that it does not take into account the intensity of light usage. A fairer basis for distribution of light cost may be determined by **engineering estimates.** These are based upon three factors:

1. Number of electric lights in a given department.
2. Wattage of the bulbs.
3. Number of hours the lighting circuit is in use each month.

An estimate of this nature requires more time to compute but provides a more accurate distribution of light cost than does an area basis. In this illustration, however, the **area basis** is used to give the following distribution (see Fig. 5):

Department	Floor Area	Percent of Total *	Distribution
90	100,000	42	$302.33
91	26,000	11	79.18
92	30,000	8	57.59
93	20,000	12	86.38
01	16,000	7	50.39
02	8,000	3	21.60
03	26,250	11	79.18
04	8,750	4	28.79
05	5,250	2	14.40
	240,250	100	$719.84

* Rounded for illustration.

Allocating the cost of electric light on the basis of the relative **number of outlets** in the departments has the virtue of simplicity. This method, however, is defective because it does not take intensity of usage into account. In those cases where all the outlets have the same size bulb and all are used the same number of hours, this basis of allocating the cost gives a reliable result.

Electric Power Cost. The power line used to deliver current to machinery and equipment should be on a separate meter from the circuit required for lighting the building. Three possible bases to be used for apportioning power cost to the various departments are:

1. Departmental electric power meters.
2. Specific machine meters.
3. Horsepower ratings of motors and hours of use.

The use of separate meters to measure the consumption of power in each department is one of the best ways to distribute electric power cost. Where large machines require heavy duty motors, and where **machine hour burden rates** are used as the method of applying burden to production, the more modern industrial concerns install a separate electric meter for each large machine. In many plants individual or even departmental electric power meters are not available. Under these circumstances an estimated distribution of power cost is made. The estimated or actual number of hours that a machine is operated is multiplied by

the horsepower rating of the motor in order to arrive at the horsepower hours of electric power consumed. A summary of these computations for all motors in a given department provides the total estimated horsepower-hour consumption for the department.

Where permanent meters have not been installed, the use of **portable meters** for limited periods may provide an equitable basis for prorating power costs. An alternative method that is sometimes used where the power line is not provided with departmental meters is to distribute the power cost on the basis of **direct labor hours** worked or **machine hours** operated in the departments. Both bases may give an inequitable distribution of power cost. In the case of the direct labor hourly basis, some of the direct labor hours worked may represent hand work that bears no relation to the number of kilowatt-hours of power consumed. The machine hour basis may also provide an inequitable departmental distribution of power used if different machines require different power loads or do not operate for the same number of hours. The following distribution is on the basis of **kilowatt-hour consumption**:

Department	Kw-h. Consumed	Cost per Kw-h.	Distribution
90	380,000	$.017996	$6,838 57
91	50,000	.017996	899.81
92	60,000	.017996	1,079.77
93	10,000	.017996	179.96
02	20,000	.017996	359 93
	520,000		$9,358 04

General Plant Costs. The distribution of general plant service costs is based upon the total man hours worked in the producing and service departments, exclusive of the powerhouse and general plant service. The cost distribution sheet (Fig. 5) shows general plant costs of $2,233.62 to be distributed. This amount is made up of the $2,200 total charge from the primary distribution and $33.62 distributed from the power department. This distribution of **general plant service** cost is shown in the accompanying table.

Department	Total Man Hours	Percent of Total *	Distribution
90	26,300	28	$ 625.41
91	32,300	34	759.43
92	7,500	8	178 69
93	18,400	20	446.73
01	2,200	2	44 67
02	1,900	2	44.67
03	4,000	4	89.35
04	2,000	2	44.67
	94,600	100	$2,233 62

* Rounded for illustration.

Factory Accounting Cost. The factory accounting department cost is distributed on the basis of total **man hours worked** in the producing departments and service departments, exclusive of the powerhouse, general plant office, and factory accounting office. The total factory accounting cost to be distributed in this illustration is $2,211.90. This amount represents the total charge from the primary distribution, $2,100, and indirect charges of $111.90 which were distrib-

uted from the powerhouse and general plant service departments (see Fig. 5). The computation for the distribution of factory accounting cost is presented in the table here.

Department	Total Man Hours	Percent of Total *	Distribution
90	26,300	29	$ 641.45
91	32,300	35	774.16
92	7,500	8	176.95
93	18,400	20	442.38
01	2,200	2	44.24
02	1,900	2	44.24
03	4,000	4	88.48
	92,600	100	$2,211.90

* Rounded for illustration.

Storesroom Cost. Storesroom cost distribution is based upon the cost of stores issued on requisitions to the producing departments and to the toolroom. The amount to be distributed is $4,230 (see Fig. 5). This amount represents the total charge from the primary distribution, $3,800, and indirect cost distributions of $430 made from the powerhouse, general plant office, and factory accounting office.

Department	Cost of Stores Requisitioned	Percent of Total *	Distribution
90	$ 92,097.39	60	$2,538.00
91	15,997.68	10	423.00
92	9,815.42	6	253 80
93	36,368.60	23	972 90
02	491.70	1	42.30
	$154,770.79	100	$4,230.00

* Rounded for illustration.

Toolroom Costs. These costs are distributed to producing departments on the basis of direct labor hours. The toolroom total of $4,270.41 is composed of the charge from the primary distribution, $3,700.00, and $570.41 of service costs distributed from the powerhouse, general plant office, factory accounting office, and storesroom.

Department	Direct Labor Hours	Percent of Total *	Distribution
90	20,000	28	$1,195.72
91	30,000	42	1,793.57
92	6,000	8	341.63
93	16,000	22	939.49
	72,000	100	$4,270.41

* Rounded for illustration.

Production Planning and Control. This cost is distributed to the producing departments on the basis of the number of items specified on production orders. The total cost of $3,573.85 comprises charges from the primary distribution, $3,300.00, and $273.85 of indirect costs distributed from powerhouse, general plant office, and factory accounting office. Computation for distribution of planning

Distribution of Service Department Costs																For January, 19__
Cost Account			Producing Departments					Service Departments							
			90	91	92	93		01	02	03	04	05	06	
Code	Name	Grand Total	Machine Shop	Finishing	Heat Treating	Assembly	Subtotal	Production Planning & Control	Toolroom	Storeroom	Factory Accounting	General Plant	Power-house	Subtotal
	Total Direct Expense ..	$77,911.71	$29,167.67	$ 8,859.80	$ 7,744.70	$ 5,039.54	$50,811.71	$ 3,300.00	$ 3,700.00	$ 3,800.00	$ 2,100.00	$ 2,200.00	$12,000.00	$27,100.00
	Service Department Distributions:													
5506-1	Heat................		$ 845.73	$ 230.65	$ 172.99	$ 249.88	$ 1,499.25	$ 134.55	$ 57.67	$ 172.99	$ 38.44	$ 19.22	$ 1,922.12	
5506-2	Light..............		302.33	79.18	57.59	86.38	525.48	50.39	21.60	79.18	28.79	14.40	719.84	
5506-3	Power..............		6,838.57	899.81	1,079.77	179.96	8,998.11	–	359.93	–	–	–	9,358.04	
													$12,000.00	
5505	General Plant........		625.41	759.43	178.69	446.73	2,010.26	44.67	44.67	89.35	44.67	$ 2,233.62		
5504	Factory Accounting...		641.45	774.16	176.95	442.38	2,034.94	44.24	44.24	88.48	$ 2,211.90			
5503	Storeroom...........		2,538.00	423.00	253.80	972.90	4,187.70	–	42.30	$ 4,230.00				
5502	Toolroom...........		1,195.72	1,793.57	341.63	939.49	4,270.41	–	$ 4,270.41					
5501	Production Planning & Control..........		1,786.93	893.46	357.39	536.07	3,573.85	$ 3,573.85						
	Total Service Cost Distributions		$14,774.14	$ 5,853.26	$ 2,618.81	$ 3,853.79	$27,100.00							
	Total Direct and Indirect Producing Departments' Cost		$43,941.81	$14,713.06	$10,363.51	$ 8,893.33	$77,911.71							

Fig. 5. Service department cost distributions made to producing and service departments on a nonreciprocal basis.

and production control cost is given in the accompanying table. The distributions are shown in **work-sheet** form in Fig. 5.

Department	Items on Production Orders	Percent of Total	Distribution
90	4,000	50	$1,786.93
91	2,000	25	893.46
92	800	10	357.39
93	1,200	15	536.07
	8,000	100	$3,573.85

SECONDARY DISTRIBUTIONS ON RECIPROCAL BASIS. The reciprocal basis of distribution recognizes the fact that services rendered by certain service departments are utilized, in part, by certain other service departments. Hence, where two or more service departments render services to each other, a **vicious circle** is created in ascertaining the amounts to be distributed to one another. The term "vicious circle" is applied to this type of problem because where two departments, A and B, are interdependent, it is impossible to know the total cost of Department A until the distribution of Department B is complete—but the distribution of Department B cannot be made until it has received its share of A's costs.

Arguments for using the reciprocal basis for secondary distribution of service department costs are:

1. If a given service department receives service from another department, the department receiving such service should be charged therefor. If two service departments provide service to each other, each department should be charged for the cost of service rendered by the other.
2. The full operating cost of a service department cannot be known unless it is charged with both direct costs resulting from the primary distributions and all indirect costs arising from secondary distributions. This includes all **interdepartmental service cost transfers.**
3. Control of service department costs includes the budgeting of both direct charges and interdepartmental service cost transfers.

There are two arguments against the use of this method:

1. It involves more work than either of the two preceding plans.
2. It is doubtful whether it provides any more reliable **costing of products.**

The first step in making reciprocal distributions is to determine the share of the total costs of each service department that is to be assigned to each of the other service departments and to each producing department. These **share calculations** expressed as percentages of the total and using the data and apportionment bases presented in the earlier illustrations are given in the subsequent paragraphs.

Powerhouse Service. The powerhouse in the previous example comprised a boiler room and an engine room. The total cost ($12,000) was apportioned between the two. The share assigned to the boiler room was converted into a unit cost per 1,000 pounds of steam. The cost of steam used for heating purposes was apportioned to all other departments (service and producing) on the basis of their cubic content. The cost of steam used by the engine room was added to other costs of this subdepartment to determine the total cost of producing electric

energy. The cost per kilowatt-hour was calculated. Records of kilowatt-hours used for lighting and for power machinery provided a basis for the apportionment of the engine room cost between these two uses of the electric energy produced. The cost assigned to lighting was distributed to other service departments and to the producing departments on an area-occupied basis. The cost of electricity used by power machinery was assigned to the departments that had used the energy on the basis of records of consumption. A summary of these distributions is shown in the accompanying table.

Department	Steam Heat Cost	Light Cost	Power Cost	Grand Total	Percent of Total
90	$ 845.73	$302.33	$6,838.57	$ 7,986.63	66.5
91	230.65	79.18	899.81	1,209.64	10.1
92	172.99	57.59	1,079.77	1,310.35	10.9
93	249.88	86.38	179.96	516.22	4.3
Subtotal	$1,499.25	$525.48	$8,998.11	$11,022.84	91.8
01	134.55	50.39	......	184.94	1.5
02	57.67	21.60	359.93	439.20	3.7
03	172.99	79.18	......	252.17	2 1
04	38.44	28.79	......	67.23	.6
05	19.22	14.40	......	33.62	.3
Total Service Cost ...	$1,922.12	$719.84	$9,358.04	$12,000 00	100.0

Other Service Departments. The same procedure is followed in the case of other service department distributions. In each case the distributive shares are expressed as percentages of the total. For example, where **man hours** are used as a basis for distribution, the man hours worked in each department are expressed as a percentage of total man hours.

The **general plant service** is distributed on the basis of total man hours worked in all departments, including the powerhouse but excluding general plant service. The same basis is used to distribute the **factory accounting service**, though in this case total man hours worked in all producing and service departments exclusive of factory accounting are used.

General Plant Service Distribution

Department	Total Man Hours	Percent of Total
90	26,300	26.9
91	32,300	33.0
92	7,500	7.7
93	18,400	18.8
Subtotal	84,500	86.4
01	2,200	2.3
02	1,900	1.9
03	4,000	4.1
04	2,000	2.0
06	3,200	3.3
Total Man Hours	97,800	100.0

Factory Accounting Department

Department	Total Man Hours	Percent of Total
90	26,300	27.0
91	32,300	33.2
92	7,500	7.7
93	18,400	18.9
Subtotal	84,500	86.8
01	2,200	2.3
02	1,900	2.0
03	4,000	4.1
05	1,600	1.6
06	3,200	3.2
Total Man Hours	97,400	100.0

Stores Department

Department	Cost of Stores Requisitioned	Percent of Total
90	$ 92,097.39	59.3
91	15,997.68	10.3
92	9,815.42	6.3
93	36,368.60	23.4
Subtotal	$154,279.09	99.3
02	491.70	.3
06	599.75	.4
Total Cost of Stores Issued	$155,370.54	100.0

Summary of Interdepartmental Service Cost Distributions. Fig. 6 summarizes the **percentages** of service department cost distributions, showing charges to be made to producing departments and those to be made to other service departments. The percentages are taken from the schedules shown in the preceding table. The percentages in the vertical columns show charges to the account indicated at the top of a column. (These are in addition to direct charges already in the departmental accounts.) The percentages in the horizontal rows indicate credits to the accounts listed at the left.

METHODS FOR SOLVING RECIPROCAL DISTRIBUTIONS.

There are three methods of solving the problem posed by reciprocal distributions:

1. Trial and error method.
2. Method of continued distribution.
3. Method of simultaneous equations.

Under the trial and error method, the object is to determine by **successive trials** the total of each service department account (including allocations from other service departments) before distribution. Under the method of continued distribution, each service account is distributed by successive trials until the remaining balances are so small that further distribution may be disregarded. Solution by **simultaneous equations** may be profitably employed where calculating machines are available and no more than three, or at the most, four, mutually interdependent accounts exist.

Trial and Error Method. This is an expedient method to use where there are more than two or three service departments affected by interdepartmental trans-

		Producing Departments	Percentage Distributions to be Made to Service Departments					
			Production Planning and Control	Toolroom	Stores	Factory Accounting	General Plant	Powerhouse
01	Production Planning and Control	100.0%	x					
02	Toolroom . . .	100.0		x				
03	Storesroom	99.3		4	x			3
04	Factory Accounting .	86.8	2.3	2.0	4.1	x	1.6	3.2
05	General Plant Service	86.4	2.3	1.9	4.1	2.0	x	3.3
06	Powerhouse . . .	91.8	1.5	3.7	2.1	6	3	x

Fig. 6. Summary of percentage distributions of service departments.

Month of January, 19__

	Percentages (Fig. 6)	1st Trial	2nd Trial	3rd Trial	4th Trial
03 Storesroom Service Department		$ 3,800.00	$ 3,800.00	$ 3,800.00	$ 3,800.00
From 04 Factory Accounting	4.1	86.10	90.86	90.95	90.95
05 General Plant	4.1	90.20	93.05	93.15	93.15
06 Powerhouse	2.1	252.00	255.18	255.33	255.33
		$ 4,228.30	$ 4,239.09	$ 4,239.43	$ 4,239.43
04 Factory Accounting Service Department		$ 2,100.00	$ 2,100.00	$ 2,100.00	$ 2,100.00
From 05 General Plant	2.0	44.00	45.39	45.44	45.44
06 Powerhouse	.6	72.00	72.91	72.95	72.95
		$ 2,216.00	$ 2,218.30	$ 2,218.39	$ 2,218.39
05 General Plant Service Department		$ 2,200.00	$ 2,200.00	$ 2,200.00	$ 2,200.00
From 04 Factory Accounting	1.6	33.60	35.46	35.49	35.49
06 Powerhouse	.3	36.00	36.45	36.48	36.48
		$ 2,269.60	$ 2,271.91	$ 2,271.97	$ 2,271.97
06 Powerhouse Service Department		$12,000.00	$12,000.00	$12,000.00	$12,000.00
From 03 Storesroom	.3	11.40	12.68	12.72	12.72
04 Factory Accounting	3.2	67.20	70.91	70.99	70.99
05 General Plant	3.3	72.60	74.90	74.97	74.98
Total		$12,151.20	$12,158.49	$12,158.68	$12,158.69

Fig. 7. Work sheet of service department cost distributions by trial and error method.

fer of services. As shown in Fig. 7, the amount of **primary cost** of each service department is the starting point in this computation. For example, the totals of direct costs charged to service departments affected by the interexchange of department services are as follows (from Fig. 5):

	Primary Expense
03 Storesroom	$ 3,800
04 Factory Accounting	2,100
05 General Plant Service	2,200
06 Powerhouse	12,000

In computing cost distributions under this method, the following steps are involved:

1. Enter the primary cost totals of each service department involved in the vicious circle in the first trial column (Fig. 7), allowing sufficient space under each service department to show the percentage of additional cost allocated from other service departments. An example follows:

	First Trial
03 Storesroom (primary cost)	$3,800.00
Services furnished to storesroom by:	
04 Factory Accounting (4.1%)	
05 General Plant (4.1%)	
06 Powerhouse (2.1%)	

2. Multiply the primary costs of the service departments which furnish the services by the percentage figure applicable to the department to which the distribution is being made.

	First Trial
03 Storesroom (primary cost)	$3,800.00
Services furnished to storesroom by:	
04 Factory Accounting (4.1% × $2,100)	$ 86.10
05 General Plant (4.1% × $2,200)	90.20
06 Powerhouse (2.1% × $12,000)	252.00
Service department cost distributed by first trial	$ 428.30
Total new storesroom cost after first trial distribution	$4,228.30

3. After the first trial distributions of all interdependent departments are completed, the process is repeated by multiplying the new cost totals by the same percentage figures as before. The new products are then added to the original primary cost totals, as shown in the following example.

	Second Trial
03 Storesroom (primary cost)	$3,800.00
Services furnished to storesroom by:	
04 Factory Accounting (4.1% × $2,216)	$ 90.86
05 General Plant (4.1% × $2,269.60)	93.05
06 Powerhouse (2.1% × $12,151.20)	255.18
Service department cost distributed by second trial	$ 439.09
Total new storesroom cost after second trial distribution	$4,239.09

4. Continue similar successive trial distributions until a result is produced that is the same as that in the previous try.

For practical purposes the process may be stopped when there remain only one or more differences of a few cents from the previous trial. It may not be con-

sidered worth the effort to run an additional trial to allocate a difference of only a few pennies.

The completed cost distributions of those service departments affected by interdepartmental transfer of services are shown in Fig. 7.

Method of Continued Distribution. This method consists of closing and reopening the departmental service accounts by successive distributions. The steps involved are as follows:

1. Apply the given percentages to prorate the primary total of the first service department. This closes the account and charges the prorated amounts to other departments.
2. Apply the given percentages to the second service department whose total is made up of primary charges plus proration from service department No. 1. This closes the second department and charges the others, including perhaps No. 1.
3. Apply the same procedure to all other service departments.
4. Repeat a second cycle of operations beginning with department No 1, whose total consists at present only of amounts prorated from other service departments. In this way the service department totals become less and less with each cycle of distributions because each time a substantial amount is charged to the producing departments.
5. Stop the process at any point where it is felt that the remaining figures are too small to be of any consequence.

The entire procedure is illustrated in Fig. 8. To prove the accuracy of the distributions, add the totals of columns 7 to 11 inclusive. They total $27,100, which is equal to the total primary charges to the six service departments before any distributions are made. To arrive at the total debits in the service department accounts after all redistributions have been made, simply add the various subtotals in each of the first four columns of Fig. 8. The resulting totals (shown below) agree with those of Fig. 7. (The costs of the production and planning control and toolroom departments are not involved, since these departments serve only producing departments.)

	Storesroom	Factory Accounting	General Plant Service	Power
Total from Cycle I	$3,800.00	$2,100.00	$2,233.60	$12,152.31
Total from Cycle II	432.88	117.58	38.34	6.33
Total from Cycle III	6.52	.81	.03	.05
Total from Cycle IV	.03			
Final Total	$4,239.43	$2,218.39	$2,271.97	$12,158.69

Devine (Cost Accounting and Analysis) calls this the **attrition method** and observes that, "The speed with which the ultimate distribution is found depends upon the size of the interdependent service percentages. The smaller the percentages applicable to other service departments, the quicker the assignment is completed."

Solution by Simultaneous Equations. From the cost distribution table (Fig. 6), a series of simultaneous equations can be formulated as follows:

(1) Let a = storesroom cost, including allocations from other departments.
(2) Let b = corresponding factory accounting office cost.
(3) Let c = corresponding general plant office cost.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
							Charged to Producing Departments from				
	Storeroom	Factory Accounting	General Plant Service	Power	Production Planning & Control	Toolroom	Storeroom	Factory Accounting	General Plant Service	Power	Prod. Plan. and Toolroom
I. Storeroom	$ 3,800.00			$ 11.40		$ 15.20	$ 3,773.40				
Factory Accounting	86.10	$ 2,100.00	$ 33.60	67.20	$ 48.30	42.00		$ 1,822.80			
General Plant Service			2,200.00								
Total Distribution	91.58	44.67	2,233.60	73.71	51.37	42.44			$ 1,929.83		
Powerhouse Expense				12,000.00							
Total Distribution	255.20	72.91	36.46	12,152.31	182.28	449.64				$11,155.82	
II. Storeroom	432.88			1.30		1.73	429.85				
Factory Accounting	4.82	117.58	1.88	3.76	2.70	2.35		102.07			
General Plant Service	1.57	.77	38.34	1.27	.88	.73			33.12		
Powerhouse Expense	.13	.04	.02	6.33	.10	.23				5.81	
III. Storeroom	6.52			.02		.03	6.47				
Factory Accounting	.03	.81	.01	.03	.02	.02		.70			
General Plant Service			.03						.03		
Powerhouse Expense				.05						.05	
IV. Storeroom	.03						.03				
Production Planning & Control (primary exp.)					3,300.00						
Total Distribution					3,585.65						$ 3,585.65
Toolroom (primary exp.)						3,700.00					
Total Distribution						4,254.37					4,254.37
Total Charges to Producing Departments							$ 4,209.75	$ 1,925.57	$ 1,962.98	$11,161.68	$ 7,840.02

Fig. 8. Work sheet for continued distribution of service department charges.

	(1) 90 Machine Shop	(2) 91 Finishing	(3) 92 Heat Treating	(4) 93 Assembly	(5) Subtotal	(6) 01 Production Planning & Control	(7) 02 Toolroom	(8) 03 Storeroom	(9) 04 Factory Accounting	(10) 05 General Plant	(11) 06 Power-house	(12) Sub-total	(13) Grand Total
Total Primary Charges...........	$29,167.67	$ 8,859.80	$ 7,744.70	$ 5,039.54	$50,811.71	$ 3,300.00	$ 3,700.00	$ 3,800.00	$ 2,100.00	$ 2,200.00	$12,000.00	$27,100.00	$77,911.71
Service Department Distributions:													
Storeroom....................	2,513.98	436.66	267.08	992.03	4,209.75		16.96				12.72	29.68	4,239.43
Factory Accounting	598.96	736.51	170.82	419.28	1,925.57	51.02	44.37	90.95		35.49	70.99	292.82	2,218.39
General Plant Expense	611.16	749.75	174.94	427.13	1,962.98	52.25	43.17	93.15	45.44		74.98	308.99	2,271.97
Powerhouse Expense...........	8,085.53	1,228.03	1,325.30	522.82	11,161.68	182.38	449.87	255.33	72.95	36.48		997.01	12,158.69
Production Planning & Control ...	1,792.83	896.41	358.57	537.84	3,585.65								3,585.65
Toolroom......	1,191.22	1,786.84	340.35	935.96	4,254.37								4,254.37
Total Secondary Charges......	14,793.68	5,834.20	2,637.06	3,835.06	27,100.00	285.65	554.37	439.43	118.39	71.97	158.69	1,628.50	28,728.50
Total Departmental Expenses. .	$43,961.25	$14,694.00	$10,381.76	$ 8,874.60	$77,911.71	$ 3,585.65	$ 4,254.37	$ 4,239.43	$ 2,218.39	$ 2,271.97	$12,158.69	$28,728.50	....

Fig. 9. Service department distributions to producing and service departments on reciprocal basis.

(4) Let d = corresponding powerhouse cost.

$$
\begin{array}{lll}
(5) & \text{Then } a = \$\ 3{,}800 & + .041b + .041c + .021d \\
(6) & b = \$\ 2{,}100 & + .020c + .006d \\
(7) & c = \$\ 2{,}200 & + .016b + .003d \\
(8) & d = \$12{,}000 & + .003a + .032b + .033c
\end{array}
$$

Transposing:

$$
\begin{array}{ll}
(9) & a - .041b - .041c - .021d = \$\ 3{,}800 \\
(10) & b - .020c - .006d = \$\ 2{,}100 \\
(11) & -.016b + c - .003d = \$\ 2{,}200 \\
(12) & -0.003a - .032b - .033c + d = \$12{,}000
\end{array}
$$

By combining equations and eliminating unknowns, the following results are obtained:

$$
\begin{array}{ll}
a = \$4{,}239.44 & c = \$\ 2{,}271.97 \\
b = \ 2{,}218.39 & d = \ 12{,}158.69
\end{array}
$$

These values are the same as those obtained by the other methods. Solution by simultaneous equations, however, becomes long-drawn out when there are three or more reciprocal transfers of interdepartmental service costs. In such cases it is not considered as practicable as the other methods discussed above. A common procedure under simultaneous equations is to eliminate successively one unknown variable at a time until only one equation with one unknown is left. (See the Accountants' Handbook, Wixon, ed., for illustration.) Cramer's rule or matrix algebra would be preferred by those familiar with these methods. Accounting departments with access to **electronic digital computers** can have simultaneous equations involving a number of unknowns solved with comparative ease.

The result of the distributions on a reciprocal basis are shown in Fig. 9.

Secondary Distribution for Specific Departments

DISTRIBUTION METHODS. The discussion in the subsequent text of the secondary distribution of the costs of specific departments is not intended as an exhaustive list but as a description of the preferred way or ways of prorating these items. The method suggested should be tested in any given circumstances or after any major change in conditions to determine whether it is fair and practicable and results in reasonable charges to each department (see comments under Proration Tests in this section).

BLACKSMITH REPAIR SHOP. This department may furnish repair service for the majority of departments in the plant. Prior to making any repairs for a given department, a **repair order** should be issued. The order should identify the department for which the repairs are to be made. Repair materials and repair labor should be charged directly to the blacksmith repair order. At the end of the month the costs of the blacksmith service department should be prorated among all repair orders on the basis of blacksmith repair labor hours. All repair shop costs are thereby absorbed and reflected as a cost of repair orders for the month. Repair orders are then classified by the departments for which the repairs were made, in order to find the total charge to each department that was served.

A more expedient but less equitable basis for distributing this repair service is on the basis of **direct labor hours** in the several producing departments. The arguments for the use of this basis are that blacksmith repairs are usually made exclusively for producing departments and that there is a definite relationship

between departmental direct labor hours and repairs required in the producing departments. The same argument is advanced in support of **machine hours** as a basis for the distribution of service costs of this type. Specific allocation based upon repair order records, however, seems the most equitable basis.

BUILDING OCCUPANCY. In some cost systems, occupancy costs applicable to all departments housed within factory buildings are accumulated and charged to a Building Occupancy account. **Floor area** of the building is the generally accepted basis for distributing costs, such as building depreciation, insurance, taxes, maintenance, and repairs, among the several departments located within the building. If ceilings are of different heights, cubic content rather than floor area may provide a better basis for the cost distribution.

In discussing the suitability of the area basis of cost allocation, the Uniform Accounting Manual for the Plastics Industry (Society of the Plastics Industry) makes the point that:

> Buildings erected at different times or of different materials may have different construction, carrying, and maintenance costs per square foot. Usually, however, the location of a particular department is not governed solely by the age or type of building, so generally it is simpler to use an average cost per square foot for all types of building used for production.

CAFETERIA. The secondary distribution of net cafeteria cost depends upon the policy of the company with respect to food prices charged employees. The cafeteria income is credited against cafeteria service costs. If income exceeds costs, the excess is considered "Other Income." Where cafeteria service costs exceed the income of this department, the "loss" may be redistributed on the basis of the number of employees on the payroll of each department. If all employees do not use the cafeteria, or if they use it irregularly, a more equitable distribution would be determined by a daily count and identification by department of employees using the facility. Such a daily statistical analysis, however, is usually too burdensome; the result obtained is not worth the effort involved.

CARPENTER REPAIR SHOP. Carpenter repair service relates to buildings and to departmental equipment such as benches, tables, and cupboards. The accounting for these costs is similar to that for blacksmith repair service. Written **repair orders** that identify the department or cost center involved should be used. Repair materials and repair labor are charged to each specific order. At the end of the month the carpenter shop costs are prorated among all orders on the basis of carpenter repair labor hours. The total of carpenter repair shop costs is distributed as follows:

1. To specific departments for carpenter repairs made on departmental equipment.
2. To Building Occupancy Service Department for carpenter repairs made on the factory building, or to an Allowance for Building Maintenance where such a method is used.
3. To Marketing Expense or Administrative Expense general ledger accounts for carpenter repairs made to either buildings or equipment classified under these two divisions of the enterprise.

Other bases, such as direct labor hours or direct labor costs in the departments affected, are sometimes used to distribute this service cost. Such bases are likely to be arbitrary, however, and may lead to inequity in apportioning the cost.

The procedure given for the carpenter shop may also be used in the case of the **electric repair shop.**

DRAFTING SERVICE. The most equitable manner of distributing the costs of the drafting room or drafting department is on the basis of the man hours of drafting work performed for the various departments. The use of formal **drafting job orders** may be necessary in certain circumstances. Direct costs can be charged to specific jobs. The overhead of the department can be allocated to the jobs at the end of each month on the basis of direct labor hours. Classification of the job orders on the basis of the departments for which the work was performed provides the totals of the departmental charges.

When the total cost of the drafting room is relatively small, the distribution of the cost on the basis of man hours worked for other departments is a satisfactory expedient.

EMPLOYEE TRAINING. A fair method for distributing employee training costs is on the basis of the number of employees trained each month for each department. If the length of the training period varies in different departments, the number of training hours would be a better basis.

EMPLOYMENT SERVICE. The employment or personnel department may render a wide variety of services affecting all employees. The most equitable basis for distribution of employment department cost is the average number of employees on the departmental payrolls each month. Vance (Theory and Technique of Cost Accounting) observes that this is the most suitable basis if the chief activity of the office is the keeping of routine **personnel records** and other work affecting all employees. If, however, the major activity of the office is the **hiring of workers,** the costs of the office should be distributed on the basis of the number hired for each of the departments during the period. Another method suggested involves a survey of the time spent on problems of each department.

ENGINEERING MAINTENANCE. Engineering maintenance service deals exclusively with current productive activities. Actual repairs and maintenance service should be accounted for by the use of **repair** and **maintenance orders.** In this manner, repair materials and labor, and the department's costs are definitely allocated to departments. If desired, a portion of engineering maintenance cost pertaining to general services, such as **periodic inspection and lubrication,** may be distributed on a basis of machine hours.

EQUIPMENT REPAIR DEPARTMENT. The preferred way to distribute the cost of this department is by separate work orders that show the department for which the repair work was performed. The direct materials and labor costs should be charged to specific repair orders. The general overhead of the department can be apportioned among the various orders on the basis of man hours or, in certain cases, on machine hours. Sorting the orders by departments and totaling the charges will provide the distribution.

FACTORY ACCOUNTING SERVICE. The factory accounting department maintains records of materials, men, machinery, and tools. The activities of the department may be so varied that it becomes difficult to find a common denominator to use in distributing the cost in a way that is considered equitable. Total man hours worked in each department is perhaps the most commonly used basis. The following bases, however, also have been advocated:

1. Number of employees.
2. Number of time tickets handled.
3. Survey of time spent on records of the several departments.

FIRE PROTECTION SERVICE. The fire protection service department renders service to all divisions of the plant. A portion of the total fire service cost, therefore, may be distributed to the marketing and administrative divisions of the business. There are two bases which may be used to distribute this cost:

1. Valuation of the property protected within the several departments and divisions.
2. Valuation of the property protected as weighted by the fire hazard experience.

Property valuation for a specific department includes the value of machinery and equipment located therein plus a proportion of the building valuation determined by floor area or cubic content of the department. **Fire hazard experience** is a weighting factor may be employed where occurrence of fires is frequent and where there is a constant hazard in certain departments owing to the nature of the productive activities carried on therein.

FLOATING LABOR SERVICE. This service is rendered to all departments as the occasion requires. The foreman of the labor gang may prepare a **daily report** which indicates the number of hours worked by each laborer for certain departments. Either this record or a **monthly analysis of time tickets** of the labor gang can be used as a basis of distribution. The total hours worked by the labor gang is divided into the total cost. The resultant cost per hour of floating labor gang service is allocated to departments that utilized the service.

GENERAL PLANT SERVICE. Costs charged to this service department or cost center are those which apply to the plant in general and which cannot be allocated or prorated expediently to specific departments. Two bases are used to distribute general plant costs: units of productive output, and total man hours.

Unit of productive output **(tonnage)** is used by some steel mills to distribute general plant or general works costs. Tonnage in this type of industry is a better basis than total labor hours because this measure is more uniformly representative of production in the several manufacturing divisions than is that of total labor or man hours.

Total man hours is considered a fair basis for distributing general plant service costs where labor is a common and dominant factor of production in all departments. This is particularly true where general plant service includes general supervision, which indirectly affects all workmen.

LOCOMOTIVE CRANE SERVICE. This service is provided for different producing departments as the need for a crane is requested. A record of the time worked for each department is shown on the daily time ticket of the crane operator. There are two bases used to distribute locomotive crane service costs: crane hours and weight of materials handled.

The **crane hour basis** is generally used to distribute locomotive crane cost. Total crane cost is divided by total crane hours in order to compute the cost per hour for crane operation. The hourly rate multiplied by the number of hours that the crane works for a given department provides the departmental charge.

In some plants the **weight of materials** which the locomotive crane handles for different departments can be obtained with little difficulty. Where this information is available, the weight handled furnishes a reasonable basis for expense distribution.

PATTERN SHOP. The costs of the department or cost center may be assigned to the patterns produced in the manner that a product is costed. Materials and labor that can be identified are charged to specific (pattern) jobs, and

departmental overhead is allocated on some reasonable basis (such as man hours). The pattern cost thus determined will be charged to a specific job or, if the pattern is to be used for several jobs, its cost may be capitalized and amortized. Lang–McFarland–Schiff (Cost Accounting) state that a common method used where patterns, special tools, and dies are made for changes in a model to extend over a period of a year is to charge the cost on the basis of actual or estimated production in the departments where these items are used.

PAYROLL SERVICE. Factory payroll service applies to all departments in the plant. Since this department accounts for the time worked by all factory workmen, the cost of operating the department may be distributed on the basis of the **total man hours** worked in each department. Many plants, however, use the **number of time tickets** handled as a basis for distribution.

PRODUCTION PLANNING AND CONTROL. This cost is distributed each month among the producing departments. Specific allocation is based upon the number of items appearing on **production orders** and their accompanying **specification schedules.** The types of items involved are departmental operations, tools, and materials, which are planned and specified on each order and which must be provided to carry on the production in each department.

PLANT MAGAZINE. The cost of publishing a plant magazine or house organ should be allocated on the basis of the **number of employees** in each department. Since the major purpose of such journals is to foster cordial labor-management relations, the number-of-employees basis is particularly suitable.

POWERHOUSE COST. Service performed by this department consists of producing steam for:

1. Building heat.
2. Power generation.
3. Compressed air production.

The costs applicable to the powerhouse are collected independently of the remainder of the plant, as though the power division were a separate institution Within the power division, cost accounts should be so arranged as to segregate the costs for the three subdivisions mentioned.

The costs assigned to the production of heat may be distributed on the basis of relative space (area or cubic content) occupied by the departments in the plant. The costs associated with the production of electric energy may be prorated on either the basis of **consumption** by the departments served or on a **dual basis** (see Combination or Dual Basis of Distribution in this section) that takes into account both the capacities of the other departments to consume power and their actual consumption for the period. The cost assigned to compressed air production may be distributed on the basis of **metered consumption** or as determined by an **engineering study** of departmental use of compressed air.

(For an analysis of powerhouse cost and a detailed example of its distribution, see Secondary Distribution on Nonreciprocal Basis in this section.)

PURCHASING DEPARTMENT COSTS. This department renders service to all divisions of the plant by placing orders for raw materials and factory supplies and for factory and office equipment, as well as for supplies and equipment for the marketing and administrative divisions. Under these circumstances, the purchasing department costs should be distributed among all divisions. Two bases for distribution of purchasing department costs are (1) the amount of the purchase orders issued and (2) the number of purchase orders issued.

The first basis requires an analysis of all invoices covered by **purchase vouchers** issued each month. The latter are analyzed as to the departments for which materials, supplies, and equipment are purchased. The money amount of the purchases for each department provides the basis for the cost distribution.

Some cost accountants feel that a more equitable distribution of purchasing department cost is on the basis of the number of purchase orders placed. This basis, likewise, requires analysis of purchase orders placed during the month, in terms of the departments in which the purchase requisitions originated. While these analyses require extra clerical work, they provide a more reasonable distribution of purchasing department cost than any other method. Direct labor hours is a basis often employed, but its use is not recommended.

RESEARCH AND DEVELOPMENT. The treatment to be given the costs incurred in the various activities collectively called "research and development" is a subject of some debate. The tremendous increase in annual expenditures for this activity means that the accounting treatment of these items may have an important effect on the determination of net income for a particular period. The central question is whether such costs should be **capitalized** and amortized over a number of periods or, alternatively, **charged off as cost** incurred in the current period. (See Research and Development Costs in the section on Accumulation of Manufacturing Overhead.)

Research and development costs can be regarded as either an element of **cost of goods sold** or as an **operating expense.** The Accountants' Handbook (Wixon, ed.) states: "Under the former, research is regarded as a part of, or an adjunct to, the manufacturing function, whereas, under the latter, research and development are usually organized and used as a general management staff function." Treating these expenditures as cost of goods sold can be accomplished by either a direct charge to that account or by the inclusion of such costs as general overhead to be assigned to products—probably by the use of **departmental overhead rates.** If the intention is to treat research and development costs as an element of plant overhead, the amount of such costs can be distributed to the producing departments on some such activity basis as man hours or machine hours. An alternative is to charge them to General Plant Service, to be prorated along with other items not clearly identified with specific departments.

STORESROOM COSTS. This department renders a service to all departments which requisition raw materials and supplies, including the marketing and administrative divisions. Hence, a portion of this service cost is prorated to the Marketing and Administrative Expense accounts at the end of each month. Bases used to distribute storesroom costs are:

1. Number of stores requisitions filled.
2. Number of stores items issued.
3. Cost of materials and supplies issued.

The number of **stores requisitions** filled by the stores department is a fair basis for distribution of storesroom service costs, if a requisition is made out for each issue of raw materials from the storesroom. This is usually the case where a **job order cost system** is in operation. In the case of **continuous production,** however (as, for example, in glass factories, blast furnaces, and cement mills), daily and monthly summary records of quantities issued are used in lieu of stores requisitions.

The number of **stores items issued** is a more equitable basis for distribution of storesroom cost, particularly if the practice is to write more than one item

on a stores requisition. Much of the cost of operation of a storesroom is identified with the issue of stores items and posting and pricing the requisitions after the issues have been made.

Where stores requisitions are not used as a basis for issue, the cost of materials and supplies issued may be a better base for distributing the storesroom expense.

TABULATING AND COMPUTING. Tabulations can be provided for production orders, stores inventory, finished stock inventory, cost of sales, raw materials and factory supplies issued, payroll and labor distribution, plant and service expense analysis, building and equipment ledger records, accounts payable, accounts receivable, budgets, marketing cost analyses including sales, cost, and expense analyses. Tabulation service cost is distributed at the end of each month to the manufacturing, marketing, administrative, and financial divisions in accordance with the relative amounts of service rendered to the respective divisions, as measured by one of the following bases:

1. Number of cards or tapes punched and processed.
2. Man hours and machine or computer hours.
3. Allocation to specific departments.

Where a wide variety of data processing is performed for all divisions of a business and for numerous departments of a manufacturing division, an equitable base for the distribution of tabulating costs may be the number of cards or tapes punched and processed. **Automatic counters** on many machines provide some of or all the needed statistics.

The number of hours each machine is operated, together with hours of **programming and set-up time** on the work for each department or division, may be used for computing the distribution of this cost. This plan requires that each employee keep a daily record of work performed.

Where the use of tabulating equipment is limited to only one application, such as payroll and labor distribution accounting, assignment of this service cost is by **specific allocation** to the department involved (payroll department or the factory accounting department, in the example given). (See the section on Basic Cost Records for discussion of the use of tabulating and data processing equipment.)

TESTING LABORATORY. The testing laboratory performs a service, as a general rule, for specific producing departments. In a foundry, tests are made for the melting department. In a steel plant, pig iron is analyzed from each run of the blast furnace, while the carbon content of steel is tested as it comes from each open-hearth heat and Bessemer converter heat. Sometimes the testing laboratory makes tests of raw materials before they are accepted and placed in stock. The distribution of this service department cost can be made on the basis of units of productive output or number of testing laboratory hours.

The **units-of-productive-output** basis provides a fair method of distributing this cost if the time required for testing is fairly commensurate with the volume of production in different departments. If this condition is not present, the **testing laboratory hours** may be used as a basis for distributing the cost. The total testing department cost for the month is divided by the total number of hours worked by laboratory testers. This rate is then multiplied by the number of hours spent by laboratory technicians in making tests for specific departments.

TIME AND MOTION STUDY AND RATE SETTING. This engineering cost usually relates to manufacturing activities only. It is distributed to the various departments in proportion to the time spent in making the studies. The

engineers engaged in this work should keep daily time tickets that indicate the department for which the work was performed.

TIMEKEEPING. This function frequently is included with factory payroll service. Where the timekeeping activity is treated as a separate service department, the cost of its operation is distributed on the basis of either man hours or number of employees.

The man-hours base seems more equitable than that of the number of employees where large amounts of overtime are worked in certain departments. This latter situation requires additional checking by timekeepers. The number-of-employees basis for the distribution of timekeeping cost provides an equitable method where little or no overtime is worked, and no special circumstances exist that cause the timekeeping for employees in certain departments to be more difficult than in others.

TOOLROOM COSTS. This department is custodian of all expensive hand tools not entrusted to the permanent possession of shop workmen and of all hand tools that are used infrequently. When tools are requested by factory workmen, it is common practice to require the presentation of a **tool check** showing the worker's number. This provides a record of the whereabouts of each tool. This service is generally referred to as **tool crib service.** Sometimes the toolroom also engages in making small tools and dies if a machine shop is not available. The costs of operating the toolroom may be distributed on the basis of direct labor hours or specific allocation to departments.

The direct labor hourly basis for distributing toolroom costs is equitable when the activity of the department consists exclusively of tool crib service. If the toolroom renders service in the form of tool or die making, a **shop or job order** should be issued to specify the character of the work. Materials and labor cost and a portion of the toolroom overhead cost should be charged to each toolroom shop or job order. The latter, in turn, indicates the department to be charged for the accumulated cost.

TRANSPORTATION SERVICE. Plant transportation service may be both external and internal. External transportation in the form of automobile truck transportation is provided in many industrial plants to haul freight and express for the stores and shipping departments. The cost of operating this department may be distributed on the following bases:

1. Automobile truck hours
2. Automobile truck miles
3. Tonnage hauled.

When automobile truck hours are used as a basis for distributing the cost of this activity, it is necessary to compute a **truck-hour cost rate.** The rate is calculated by dividing the total cost of operating the department by the total number of truck hours operated. The cost is then distributed by multiplying the automobile truck-hour rate by the number of hours of service rendered to each department. The record of hours worked is prepared by the operator of the truck.

Automobile **truck miles** provide an equitable basis for distributing trucking costs, particularly where long hauls are involved. Under this plan it is necessary for the truck operator to keep a daily record of the miles operated for each of the different departments and divisions of the plant. The **tonnage** basis for distributing automobile service department cost may give equitable results and can

be used if records of tonnage handled for each department can be obtained without great difficulty.

The **internal transportation** or **materials handling system** is used to transport materials and supplies from the storesroom to the producing departments, to carry scrap from a producing department to the storesroom or salvage yard, and to handle interdepartmental transfers of work in process and finished goods. A common practice is to charge the storesroom for the delivery of materials to the producing department where they are to be used. Each producing department is charged, in turn, with the cost of moving the work to the next process or department. In this manner the producing department in which the last manufacturing operation is performed is charged with the cost of transferring the finished products or jobs to the finished stock warehouse or to the shipping platform. The cost of the internal transportation service may be prorated on the basis of either **truck hours** or **tonnage hauled.** The truck-hour basis usually provides the easier plan for distributing this service cost. The basic records are compiled by the truck operators; they prepare time tickets showing the number of hours worked in, or for, each department. Weight of the materials transported, however, may represent a better measure of the cost of internal transportation. The difficulty involved in utilizing this basis is in obtaining accurate weights of materials transferred.

WATER PUMPING AND TREATING. Some industrial enterprises which consume a large volume of water have their own **water plants** from which water is pumped from wells or from rivers and lakes. The total monthly cost of operating this department is divided by the number of thousands of gallons of water pumped during the month, to determine the unit cost of pumping. Records of water consumption for each department times the pumping cost per unit gives the charge to each department. The use of meters is the most reliable means of determining departmental consumption. **Meters** should be installed in each department where large volumes are consumed. Another meter should be provided to measure water used for drinking and washroom purposes. The cost of water used for these latter purposes usually is charged to the building service department or to general plant service.

YARD SWITCHING SERVICE. This department renders service primarily for the stores department and the shipping department. This means that the expense of this activity is distributed to both manufacturing and marketing divisions. The bases which can be used for the distribution of this service are:

1. Switching hours.
2. Number of cars handled.
3. Tonnage handled.

In each case a **unit cost** of yard switching service is computed by dividing monthly yard switching costs by the units of whichever base is to be used. The unit switching cost is then multiplied by the number of units of service rendered to each department and division in order to distribute the cost. **Switching hours** and **number of cars handled** provide satisfactory bases for the distribution of yard switching service. Tonnage handled, however, usually does not provide a basis as adequate or expedient as the other two. The reason is that a special record of tonnage handled must be kept by the yard switchmen, and this in turn necessitates recording the weight of empty cars in addition to load weights. If "empties" are not included in the tonnage record, a reliable cost distribution cannot be provided.

Cost Distribution Sheet

PURPOSE. A cost distribution sheet is a facilitating device. It is used as an aid in the end-of-period process of allocating or apportioning factory overhead to the various departments (producing and other) and of reassigning the costs of service departments to the end that all the overhead is charged to producing departments (and in some cases to certain nonmanufacturing departments). While the distribution and redistribution processes could be accomplished without preparing a cost distribution sheet, its use usually makes the task easier. The number of journal entries needed to record the distributions in the formal records can be greatly reduced if the work sheet is used. It provides totals for **compound summary entries.**

PREPARATION. As in the case of most working papers prepared by accountants, the form of the distribution sheet can be varied to suit the need and circumstances. The traditional arrangement of the manufacturing cost distribution sheet has the names of the cost accounts involved listed at the left, with each account balance in the first amount column. An amount column is provided for each producing and service department with the name and/or number shown in the heading. The columns for the producing departments usually are placed at the left of those for the service departments, though reversing the positions would serve just as well.

In some cases various statistics that provide the bases for all or many of the distributions are placed at the top of the sheet before the accounts, their balances, and the distributions are shown. Another useful variation is the inclusion of an **explanation column** between that for the account names and the first amount column. This extra column is used to note the basis of distribution for each cost.

Fig. 10, adapted from Vance (Theory and Technique of Cost Accounting), illustrates a cost distribution sheet containing several features previously mentioned. The dollar amounts shown in the "Total Cost" column are the balances in the subsidiary manufacturing cost ledger controlled by a general ledger account entitled "Manufacturing Overhead Control." It could be that no subsidiary ledger and related control account would be used; all the accounts shown could be in the general ledger. The preparation of the cost distribution sheet would be the same in either case.

The arrangement of the service department columns should be noted. Nonreciprocal distribution of service department costs is followed in Fig. 10. Building Service serves the Stores department as well as all three producing departments while the Stores department serves only the three producing departments. The columns for the service departments were arranged so that the one whose total was to be distributed first was placed at the left of the one whose total was to be distributed second, etc. (Some cost accountants would exactly reverse this order, placing at the far right the column whose total was to be first distributed, then the next to be closed, etc. The partial cost distribution sheets illustrated in the preceding pages have this latter positioning of the service department columns.)

CLOSING THE COST ACCOUNTS. The cost distribution sheet accumulates the data needed to prepare entries to close the manufacturing overhead accounts. The **closing entries** may be as detailed or as summarized as the accountant wishes. Separate entries can be made to distribute each cost to the proper departments, followed by entries to redistribute each service department

Item	Distribution Base and Rate	Total Cost		Service Departments: Building Service		Service Departments: Stores Dept.		Producing Departments: Machine Shop		Producing Departments: Assembly Dept.		Producing Departments: Painting Dept.	
Indirect materials	(Direct charge)*	$ 159	91	$ 42	10	$ 18	25	$ 56	80	$ 24	16	$ 18	60
Indirect labor	(" ")	2,083	00	378	00	426	00	524	00	436	00	319	00
Depreciation of equipment	(" ")	496	60	32	50	56	90	227	10	94	60	85	50
Property taxes	3% per year of book value of property used or stored	472	00	130	00	142	00	110	00	40	00	50	00
Social Security taxes	3.8% of total payrolls**	223	55	14	36	16	19	76	91	84	97	31	12
Casualty Insurance	$0.70 per $100 of value of property used or stored	139	00	38	00	41	00	27	50	14	30	18	20
Power	$0.02 per kilowatt hour used	226	00	18	40	8	10	142	90	34	10	22	50
Repairs	(Direct charge)	174	60	45	80	16	30	89	00	5	40	18	10
Sundry	$2.10 per worker	52	50	4	20	4	20	18	90	16	80	8	40
Totals		$4,027	16	$ 703	36	$ 728	94	$1,273	11	$ 750	33	$ 571	42
Redistribution of service department costs:													
Building service	$0.25 per square foot of floor space	—		(703	36)	125	00	226	50	151	25	200	61
						$ 853	94	$1,499	61	$ 901	58	$ 772	03
Stores Department	$0.21348 per requisition	—				(853	94)	426	96	298	88	128	10
Totals		$4,027	16					$1,926	57	$1,200	46	$ 900	13

* "Direct charge" means that no distribution base is needed, the data are obtained by analysis of materials requisitions, labor records, depreciation computation, etc

** 2 50% FOA; 1 0% state unemployment, 0 3% federal unemployment It is assumed that no employee has thus far this year earned $3,000

Fig. 10. Manufacturing overhead distribution sheet.

cost. Most accountants would see no advantage in so many entries, but instead, would make one compound entry to record the primary distribution and close the cost accounts, and another compound entry to record the secondary distributions and close the service department accounts. Alternatively, one single compound entry can be made to close the cost accounts and charge the producing departments and, perhaps, nonmanufacturing departments. The debits are provided by the producing-department column totals on the last line of the cost distribution sheet; the credits are to the accounts shown in the original listing at the left for the amounts shown in the first column. (If the cost accounts are in a subsidiary ledger, the credit in the general ledger goes to the control account.)

FINAL STEP AFTER DISTRIBUTION OF MANUFACTURING OVERHEAD. After all service department costs have been distributed under whatever plan may be used, the total service costs are entered in the **production department accounts.** The production department cost totals now represent the direct production department costs and indirect service costs distributed to production departments. These amounts can be used to obtain applicable overhead rates for assigning the departmental cost to production. If predetermined rates are used, the producing department cost totals will be compared with charges to production to determine the amount of over- or underabsorbed departmental overhead.

SECTION 9

MANUFACTURING OVERHEAD AND PRODUCT COST

CONTENTS

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Direct Costing

Summary of Methods for Applying Overhead to Products

SECTION 9

MANUFACTURING OVERHEAD AND PRODUCT COST

Nature of Manufacturing Overhead Rates

CHARACTERISTICS OF MANUFACTURING OVERHEAD. Manufacturing overhead, also known by such other names as **manufacturing expenses, indirect factory costs,** and **factory burden,** includes all factory operating costs other than direct materials and direct labor. Within this group of manufacturing overhead costs are a wide variety of items encompassing such costs as the following:

1. **Indirect materials:** materials and supplies which are consumed in the factory but which do not become a part of the manufactured product.
2. **Indirect labor:** salaries and wages which are paid to personnel working in the factory but not directly on the manufactured product.
3. **Other indirect factory costs:** charges for insurance, rent, property taxes, utilities, and other services purchased outside the firm and utilized during the period; also, depreciation on factory assets.

For a more complete discussion of the different categories of cost included under manufacturing overhead, see the section on Accumulation of Manufacturing Overhead.

Relation to Product. One of the most important characteristics of manufacturing overhead items is that while these costs are ordinarily quite easy to measure, it is usually impossible to trace them to individual **units of product**, or even to larger segments of output such as individual **jobs**, or **production lots.** Unlike direct material and direct labor, manufacturing overhead does not show up on the finished product, nor is there evidence such as from a time ticket or a stores requisition, of its contribution to specific products Manufacturing overhead, however, is as much a part of the total cost of the product as the materials and labor which enter the product directly.

Relation to Volume. Another important characteristic of manufacturing overhead is that at least some of these costs do not change in the same proportion as the volume of output. Some costs, called **fixed costs,** remain relatively constant from month to month regardless of changes in the number of units produced. Other costs, called **semi-variable costs,** vary from month to month but not in the same proportion as the number of units produced. There are several types of semi-variable costs: some vary seasonally; some behave as though composed partly of a fixed element and partly of a variable element; some increase in step fashion at certain critical points on the volume-of-output scale; and others may behave in a curvilinear fashion, increasing more rapidly at some points on the volume-of-output scale than at others. When the volume of output changes from month to month, the combined effect of the different behavior patterns for

overhead costs and the changing volume of output is such that the unit costs of the product fluctuate considerably from month to month unless something is done to normalize overhead cost charges to product.

Method of Overhead Application. Methods must be devised to spread manufacturing overhead costs properly over the production of the period. Selection of the correct method of overhead application, also called **overhead costing** or **overhead absorption,** is vital; otherwise, pricing policies, bids and estimates, decisions regarding product emphasis, and sales controls in general are affected adversely; inventories are incorrectly stated; and the net profit reported for the period is inaccurate. Overhead application is accomplished by the use of **overhead rates.**

PURPOSE OF OVERHEAD RATES. Overhead rates, also called **burden rates,** are used for four related purposes:

1. To compute the proper amount of manufacturing overhead to be included in the cost of individual jobs, production lots, batches, or processes.
2. To permit this computation to be made promptly upon the completion of production.
3. To provide the basis for the formal accounting entries transferring cost from manufacturing overhead cost accounts to work-in-process inventory accounts
4. To estimate manufacturing overhead costs applicable to a product in advance of actual production.

Overhead rates are not suited for **budgeting** or **forecasting** the manufacturing overhead costs of a factory or subdivision thereof.

It is not easy to determine the proper amount of overhead to be included in the cost of a product. As expressed by Boyd and Dickey (Basic Accounting):

> The task of charging such costs to the jobs they benefit is more difficult than is the case with direct materials and direct labor. The requisition for the direct material may be charged to the production order for which it was withdrawn, and the time of the direct laborer may be charged, on his time ticket, to the particular job on which he worked. But the depreciation of the building or the salary of the factory superintendent or of the night watchman requires more involved handling before being charged against the production orders they benefit.

Further, modern industrial trends increase the difficulties, as explained by Franklin (NAA Bulletin, vol. 32):

> The problem is being made more and more acute every day by the growing tendency to effect reductions in prime cost at the expense of increases in overhead cost. When a large, single purpose machine tool is purchased with the objective of reducing machining time, the base used for applying overhead (whether it be direct labor or prime cost) is reduced, and the overhead costs of depreciation, power, and the like are increased. As a result, overhead rates are climbing rapidly, and any errors contained in allocating overhead are also growing.

The problem is partly mechanical and partly conceptual. The mechanical part of the problem arises because of the impossibility of tracing all overhead costs to specific jobs, lots, processes, or batches. In the final analysis, some more or less arbitrary method of overhead application must be resorted to. A properly chosen overhead rate will permit the **overhead allocation** to be made in an equitable and logical manner.

The conceptual part of the problem has to do with the desirability of normalizing the overhead charge. If the actual overhead costs of the month are spread over the output of the month, then the unit costs of individual products will

fluctuate capriciously from month to month, due to the combined effects of changing volume of output and the incidence of nonvariable overhead costs. Thus **overhead rate methods** not only provide an equitable and logical basis for overhead application but also smooth out the uncontrollable and somewhat illogical month-to-month fluctuations in unit overhead costs.

For proper control of operations, management needs to know unit costs of output promptly upon the completion of production. When perpetual inventory records are kept, the cost of completed production must be determined promptly in order to permit the transfer of cost from work in process to finished goods, and from finished goods to cost of sales. In most situations, overhead rates provide the only feasible method of computing product overhead costs promptly enough to serve these needs.

USE OF OVERHEAD RATES IN COSTING PRODUCTS. Overhead rates are used with both **job order** and **process cost** accounting systems and with both **actual cost** and **standard cost** systems.

Job Order Costing. Fig. 1 illustrates how the material, labor, and overhead costs of a product are computed under a job order cost system employing actual, rather than standard, costs. The actual costs of raw material and direct labor used on the job are determined from **stores requisitions** and **time cards** and are entered in the lower half of the **job order cost sheet.** Overhead costs cannot be traced to the job in this same way. Instead the cost accountant determines from cost studies what amount of overhead costs normally can be expected for each hour of direct labor. (Machine hours, direct labor dollars, and other bases are also used. These and other refinements in procedure are discussed under Overhead Rate Formulas and Their Use in this section.) The relationship of overhead to direct labor is expressed as an overhead rate: \$2.00 per direct labor hour in the example shown in Fig. 1. Then product overhead is calculated (14 direct labor hours $\times$ \$2 = \$28), and this amount of overhead is entered on the job order cost sheet. Thus the total cost of \$134.64 shown for the 50 units manufactured on the job represents actual materials and labor costs plus estimated manufacturing overhead costs. The cost of the job is known immediately after it is completed, so that the cost of the product can be picked up in the finished goods inventory records and so that management can promptly make whatever adjustments it deems advisable, such as to change emphasis on product lines or to adjust prices. The unit cost is determined by dividing the total cost of the job by the number of units produced.

When predetermined costs are needed for pricing or other purposes, **product costs** may be estimated by estimating material and labor from past experience and by using the current overhead rate, as in the preceding example, to estimate overhead charges. Accurate cost estimating is particularly important with a job order system, since the companies employing this costing method often deal in a line of products which are manufactured to individual specifications furnished by the customer. (For further discussion, see section on Estimated Costs.)

Under a job order cost system, the formal record applying overhead costs to production is recorded at the end of each month by transferring cost from the **Manufacturing Overhead account** to the **Work-in-Process Inventory account.** This is done by an entry such as the following:

Work in Process	xxx	
Manufacturing Overhead		xxx

(To apply overhead costs to Work-in-Process inventory.)

Job Order No.: 1014

Product No.: No. 146 Earrings

Quantity Ordered 50

Quantity Inspected: 50

Date Promised: 20 Oct. 19__

Date Started: 10 Oct. 19__

Date Shipped: 15 Oct 19__

Customer: Reynolds Distr.

143 Atlas Avenue

Cortland, New York

Salesman: Smart

Sales Price: $4.02

Raw Material					Direct Labor					Overhead Applied			
Date	Req. No.	Part No.	Qty.	Total Cost	Date	Time Card No	Oper.	Hr.	Total Cost	Date	DL Hr.	Ohd Rate	Total Cost
10/10	1423	42	100	$14.22	10 10	8009	22	8	$32.00	10 14	14	$2.00	$28.00
	1423	48	100	27.22	10,12	8116	42	2	10.00				
	1423	102	100	11.20	10 13	8224	45	4	12.00				
				$52.64				14	$54.00				

Cost Summary	
Raw Materials Total.	$ 52.64
Direct Labor Total ..	54.00
Overhead Total	28.00
Total Cost	$134.64
Unit Cost	$ 2.693

Fig. 1. Job order cost sheet showing use of an overhead rate in costing a product.

In cases where a separate work-in-process account is maintained for each of the three elements of cost, the debit would be to Overhead in Process.

The amount transferred is determined by the use of the overhead rate, i.e., it is equal to the total amount charged during the month to the various job order cost sheets. The balance left in the Manufacturing Overhead account is the difference between actual overhead costs incurred and those charged to production. It is referred to as the **unabsorbed overhead** (debit balance) or the **overabsorbed overhead** (credit balance) and arises because the overhead rate is only an estimate of the proper amount of overhead costs and will be equal to actual overhead costs only when cost levels and output levels are exactly the same as those upon which the overhead rate is based. Unabsorbed or overabsorbed overhead costs are handled in a variety of ways. (See "Disposition of Overhead Balances" in section on Manufacturing Overhead and Normal Activity.)

Process Costing. Under a process cost accounting system, unit costs are computed by dividing the total weekly or monthly cost of each process by the output of that process, as determined by **equivalent production** calculations. In Fig. 2, for example, equivalent production calculations indicate that the labor and overhead costs are to be spread over 47,000 units for the cleaning process, over 41,000 units for the cooking process, and over 36,000 units for the packing department. The equivalent production for materials costs is different because materials are added to each process all at one time (at the beginning of the cleaning process but at the end of the packing operation), while labor and overhead is added gradually.

Fig. 2 illustrates the use of overhead rates with a process cost system. While a process cost system can produce product costs without employing overhead rates, overhead rates often are used, since they speed up cost calculations (thus permitting cost reports to be prepared weekly and even daily) and since they offer other distinct advantages when cost levels or production levels are subject to wide **seasonal variations.**

The costs which are to be divided by the equivalent production are shown in Fig. 2 as "Costs added, this department." The determination of materials and labor costs for each department poses no special problem, since these costs can be readily summarized from materials requisitions and labor time tickets. The **distribution of overhead,** on the other hand, is such a difficult and time-consuming task that many firms have turned to the use of overhead rates in order to speed up calculations. When overhead rates are not utilized, the procedure in general is as follows: Overhead costs are charged directly to producing and service (nonproductive) departments, as incurred. At the end of each week or month (or as often as unit cost calculations are to be made), service department costs are distributed to the departments benefiting from the services performed, so that gradually all service department costs become distributed to producing departments and are thus determined for unit cost calculations. (For a detailed description see section on Distribution of Manufacturing Overhead.)

When **overhead rates** are to be used, the procedure is very similar to that discussed previously for a job order cost system. The cost accountant determines from **cost studies** what amount of overhead normally can be expected for each hour of labor expended in the producing department (Machine hours and other bases are also used, and there are several other refinements in procedure which are discussed subsequently in this section) A separate overhead rate usually is computed for each producing department, to allow for differences in the costliness of the various processes. The overhead rates include an allowance to cover a

For the Week Ending Nov. 7, 19__

	Cleaning		Cooking		Packing	
Quantity Schedule						
Units started		50.000		45.000		40,000
Units transferred out	45.000		40,000		35,000	
Units in process 11/7 (percent converted)	4.000(50%)		3.000(33⅓%)		4.000(25%)	
Units lost	1.000	50.000	2,000	45.000	1.000	40,000
Equivalent production, mat.	49.000				35.000	
Equivalent production, Lab. & Overhead	47.000		41,000		36,000	
	Total Cost	Unit Cost	Total Cost	Unit Cost	Total Cost	Unit Cost
Costs Charged to Department						
Costs, preceding departments:						
Cost of units transferred in			$ 77,400	$1.72	$140.400	$3.51
Costs added, this department						
Material (summary of requisitions)	$24 500	$ .50			$ 3.500	$ .10
Labor (summary of time tickets)	29.140	.62	$ 37,310	$ .91	32.400	.90
Overhead **(calculated: overhead rate × labor hours)**	28.200	.60	32 800	.80	19,800	.55
Total cost added	$81 840	$1.72	$ 70,110	$1.71	$ 55.700	$1.55
Adjustment for lost units				.08		.09
Total cost to be accounted for	$81,840	$1 72	$147.510	$3 51	$196.100	$5.15
Cost accounted for as follows:						
Cost transferred out		$77.400		$140.400		$180,250
Work in process						
Cost from preceding departments			$ 5,400		$ 14,400	
Materials added	$ 2.000					
Labor added	1.240		910		900	
Overhead added	1.200	4.440	800	7.110	550	15,850
Total cost accounted for		$81 840		$147 510		$196.100

Fig. 2. Production cost report showing use of overhead rates in costing a product.

proper share of indirect service department overhead costs. Once the rates have been determined, they are used as often as necessary to calculate the amount of overhead to be entered into the **production cost report.** Thus, in Fig. 2, the overhead for each department is calculated by multiplying the departmental overhead rate by the labor hours expended in the department. Consequently, when overhead rates are employed, unit cost calculations represent actual materials and labor costs, but estimated overhead rates are normalized in such a way as to smooth out uncontrollable seasonable (and possibly cyclical) fluctuations in unit overhead cost.

When **weekly unit cost calculations** are desired under a process cost system, the overhead rate method is the only feasible way of obtaining a usable overhead cost figure for each department. Even when the firm desires only monthly unit cost summaries, the overhead rate method offers distinct advantages in speeding up calculations and in smoothing out seasonal variations in unit costs arising from wide fluctuations in certain overhead costs or from fluctuations in volume of output.

When overhead rates are used with a process cost system, the formal **entry to apply overhead costs** to the various processes is as follows:

Work in Process, Cleaning Dept.	$28,200	
Work in Process, Cooking Dept.	32,800	
Work in Process, Packing Dept.	19,800	
Manufacturing Overhead		$80,800
(To apply overhead costs to work-in-process inventory.)		

The figures shown are those illustrated in Fig. 2. The Manufacturing Overhead account often is departmentalized so that **overabsorbed or unabsorbed overhead** is determined separately for each department.

PREDETERMINED VS. HISTORICAL OVERHEAD RATES. Overhead rates should be predetermined; i.e., they should be computed in advance of the period to which they apply. Although it is possible to compute an overhead rate after the period has gone by and to use this rate to apply the actual costs of that period, the use of a historical overhead rate such as this involves important disadvantages.

Historical rates delay product cost calculations at least until the end of the month and often later. Historical rates also are subject to wide fluctuations from one month to another because of seasonal and cyclical influences acting upon actual overhead costs and upon the actual volume of activity over which overhead costs are spread The result is an undesirable fluctuation of product costs, one which tends to hide or distort the cost changes management seeks to control.

When a **predetermined overhead rate** is used, product cost calculations are determinable as soon as production is completed. Furthermore, the overhead cost which is applied to product is not distorted by seasonal fluctuations. (Cyclical fluctuations may also be smoothed out when **normal or practical capacity rates** are used.) Prompt determination of cost is desirable and often essential in modern-day industry. Whenever perpetual inventory records are being employed, the cost of each product must be known when it comes off the production line, in order to be transferred into the finished goods inventory records. Where pricing is accomplished on a **cost plus** basis, prompt cost calculations are needed for billing purposes. In almost every firm a more effective job of cost control can be accomplished if product costs are determined promptly upon completion of manufacture.

According to a survey conducted by the Research and Technical Service Department of the National Association of Accountants, "Practice in Applying Overhead and Calculating Normal Capacity" (NAA Bulletin, vol. 19), an overwhelming majority of firms employ predetermined rather than historical overhead rates. Where historical overhead rates are found, it is usually in an exceptional situation in which the advantages of a predetermined rate are not especially important. This is true of the canning industry, where production is accomplished during a comparatively short period of each year.

SOURCES OF DATA FOR ESTABLISHING OVERHEAD RATES. In most situations overhead rates are computed from data developed in the firm's **operating budget**, but overhead rates can be computed without using a budget.

Budget Method. The budget is a detailed plan of intended operations and their effect upon the firm. It should be based upon a realistic appraisal of the best course of action open to the firm. Details set forth in the budget show, among other things, the intended levels of operating activity and the overhead costs which are to be expected as the firm operates at different activity levels. From this information overhead rates are readily determined for either the **intended level of activity** or for some other level, such as **normal activity** or **practical capacity.** Actually their calculation is a part of the budgetary procedure. Fig. 3, adapted from Matz–Curry–Frank (Cost Accounting), illustrates the calculation of an overhead rate for one department of a factory, working with figures developed as a part of the firm's budget.

Method Without Budget. If the company does not compile an operating budget, then the data for calculating overhead rates must be estimated separately. Such an estimate can be made by studying the behavior of costs during recent experience, adjusting where necessary for changes in probable purchase prices, for changes in the size or composition of the organization or the plant facilities, and for changes in the level of activity planned for the period ahead.

For example, assume that recent experience has been at the level of activity represented by 10,000 direct labor hours per month for which actual monthly costs have been:

Recent Experience: 10,000 direct labor hours
Overhead rate calculation

Actual fixed overhead	$10,000
Actual variable overhead	50,000
Total actual overhead costs	$60,000, or $6 per direct labor hour (D.L.H.)

Data for calculating overhead rates are worked out in the following cases, which assume three different sets of conditions.

Case 1. If the company plans to operate next year at 8,000 direct labor hours per month without any significant change in purchase prices and without any important change in the size or composition of the organization or plant facilities, then the estimate for total overhead costs and the **computation of the overhead rate** would be as follows:

Forecasted Experience: 8,000 direct labor hours, same purchase prices, same organization and facilities, and therefore same variable overhead rate of $5 per hour.
Overhead rate calculation

Estimated fixed overhead	$10,000 (unchanged)
Estimated variable overhead	40,000 = ($5.00 × 8,000 hours)
Total estimated overhead costs	$50,000, or $6.25 per D.L.H.

The overhead rate is increased by 25 cents per hour because the fixed costs must be spread over a smaller number of hours:

Recent Experience: $10,000 fixed costs ÷ 10,000 hours = $1.00 of fixed cost per hour.
Forecasted Experience: $10,000 fixed costs ÷ 8,000 hours = $1.25 of fixed cost per hour.

The **variable part of overhead** is $5.00 per hour in both cases so that the 25-cent increase in the overhead rate is explained by spreading **fixed costs** more heavily on each direct labor hour.

Case 2. In times of **changing price levels,** the overhead rate must also allow for the higher or lower purchase prices which are expected to prevail during the next period for indirect materials, indirect labor, and other purchased services. Proper allowances for purchase price changes is often quite difficult, since some overhead items such as indirect materials and indirect hourly paid labor are very sensitive to price level changes, while others, such as insurance, taxes, and depreciation, are relatively insensitive. If the company anticipates a 5% average increase for purchase prices but it is felt that half of the fixed overhead costs will not respond to this price change, then the estimate for total overhead costs at 8,000 direct labor hours and the computation of the overhead rate would be as follows:

Forecasted Experience: 8,000 direct labor hours, purchase prices increased 5% but half of fixed costs unaffected, same organization and facilities.

Overhead rate calculation

Estimated fixed overhead	$10,250.00 = $5,000.00 + (1.05) ($5,000.00)
Estimated variable overhead	42,000.00 = (1.05) ($40,000.00)
Total estimated overhead costs	$52,250.00, or $6 53125 per D.L.H.

The increase in the overhead rate from Case 1 to Case 2 is $0.28125 ($6.53125 − $6.25). This increase is explained by the 5% increase in the variable overhead and by the small increase in the **level of fixed overhead** costs.

Case 3. Often, however, a firm plans to make certain adjustments in the composition or size of its organization or its plant facilities. Adjustments of this type may lead to a different level of fixed overhead and may also cause changes in the variable overhead. Changes such as these are usually difficult to gage correctly; yet early consideration must be given to these influences if the decision to make the adjustment is to rest on solid ground.

If the company anticipates the same price changes as given for Case 2 and also plans certain expansions in personnel and facilities, such as to add $2,000 per month to the fixed costs (for added salaries, taxes, depreciation, etc.), while permitting a 9,000 direct-labor-hour **level of activity,** then the estimate for total overhead costs at 9,000 direct labor hours and the computation of the overhead rate would be as follows:

Forecasted Experience: 8,000 direct labor hours, purchase prices increased 5% but $5,000 of fixed costs unaffected, change in organization and facilities.

Overhead rate calculation

Estimated fixed overhead	$12,250 = $5,000 + (1.05) ($5,000) + $2,000
Estimated variable overhead	47,250 = (1.05) ($45,000)
Total estimated overhead costs	$59,500, or $7.4375 per D.L.H.

The increase in the overhead rate from Case 2 to Case 3 is $0.90625 ($7.4375 − 6.53125). This increase is explained by the partly counteracting effects of an

increase in the **level of fixed costs** and an increase in the **number of direct labor hours** over which the total fixed costs need to be spread.

In the examples covered by Cases 1, 2, and 3, it is assumed that the firm wanted to base overhead rates upon actual expectations for the period covered, rather than upon normal business conditions or upon conditions of practical (full) capacity.

OVERHEAD DISTRIBUTION VS. OVERHEAD APPLICATION. The terms overhead distribution and overhead application are frequently confused. Schlatter and Schlatter (Cost Accounting) say that overhead distribution involves the assignment of actual manufacturing overhead costs among the various departments so as to determine the overhead costs incurred in operating each department (a functional classification). (For details, see section on Distribution of Manufacturing Overhead.) Overhead application involves the assignment of manufacturing overhead cost to the products worked upon during the period so as to determine unit costs for the products manufactured. **Product costs** represent a compilation of several functions.

Journal Entries for Overhead Application. Overhead application is accomplished by the use of overhead rates. Overhead is applied to the job weekly, monthly, or when the job is completed. This third element of cost, added to the direct materials and direct labor, gives the full factory cost of the product. Overhead rates may also be employed with a **process cost accounting system.** Overhead application is reflected at the end of the month by journal entries such as the following, which assume the use of departmental overhead rates:

Work in Process	$19,500	
Manufacturing Overhead: Machining Dept. ..		$12,000
Manufacturing Overhead: Assembly Dept. ..		7,500

(To apply manufacturing overhead costs to the production of the month.)

Machining Dept.: 6,000 D.L.H. × $2.00 overhead rate per hour.
Assembly Dept.: 7,500 D.L.H. × $1.00 overhead rate per hour.

Underabsorbed or Overabsorbed Overhead. The results of the **overhead application** are reflected at the end of each month in the manufacturing overhead accounts of the producing departments, as shown in the following "T" account form.

Manufacturing Overhead: Machining Dept.

Direct	$8,000	Applied	$12,000
Indirect	5,000		

Manufacturing Overhead: Assembly Dept.

Direct	$5,000	Applied	$7,500
Indirect	2,000		

The debit side of each account shows the overhead distributed to the producing department, part of which was charged directly to the department as it was incurred and part of which was redistributed at the end of the month from service departments (and possibly from other general factory overhead accounts). The credit side of each account shows the overhead applied to production, and thus included in the cost of the product. In applying overhead, the accountant in

effect is closing out to work in process a certain amount of the overhead distributed to the department. The balances which remain in the manufacturing overhead accounts are called **unabsorbed** (or underabsorbed) overhead if there is a debit balance and overabsorbed overhead if there is a credit balance. These balances are also referred to as **overhead variances, burden variances,** and **overapplied or underapplied overhead or burden.**

Classifications of Overhead Application Methods

FEATURES WHICH DISTINGUISH DIFFERENT OVERHEAD RATES. The exact nature of the overhead rate differs from one company to another. Even within the same firm, several different kinds of overhead rates may be in use. Overhead rates may be classified with regard to at least seven **characteristics,** each of which is discussed subsequently in this section:

1. Whether the rate includes fixed costs or not.
   a. Absorption costing.
   b. Direct costing.
2. The nature of the base used to apply overhead to product, such as direct labor dollars, direct labor hours, and machine hours.
3. The activity level assumed for the absorption of fixed costs.
   a. Expected activity for the year.
   b. Normal activity for the next three to five years.
   c. Practical capacity.
4. Whether the rate applies to the whole plant or only to a subdivision thereof.
   a. Plant-wide or blanket rate.
   b. Departmental rates.
   c. Cost center rates.
   d. Operational rates.
5. Whether the rate applies to all product lines or to one certain line of product.
6. Whether separate rates are used for applying materials-related overhead, labor-related overhead, or machine-related overhead.
7. Whether separate rates are used for applying fixed overhead and variable overhead.

These different characteristics may be combined in such a wide variety of ways that the exact nature of an overhead rate is clearly revealed only when all the particulars regarding it are set forth. It is not sufficient to say that the firm uses a direct labor hour rate or that the firm uses a normal overhead rate. Several different firms may employ rates embodying both these characteristics and yet have **overhead rate structures** which differ widely. For example, one firm may be using absorption costing, basing applied overhead on direct labor hours, at normal activity through a plant-wide rate, using one rate for all products and for all overhead components. Other firms may also employ direct labor hourly rates based on normal activity, but they may differ one from another with regard to the departmentalization of burden rates, the use of separate rates for each product line, or the use of separate rates for applying materials-related overhead. There are almost innumerable combinations of the many possible variations.

DIRECT VS. ABSORPTION COSTING. Traditional cost accounting procedures endeavor to apply all costs incurred in, or for, the factory to the output of the period. Under this approach, called absorption costing, both fixed and variable manufacturing overhead costs are included in the overhead rate and absorbed as a part of the cost of the product manufactured during the period. In recent years a number of accountants have advocated an overhead application

method, called "direct costing," under which only the **variable manufacturing overhead** costs are included in the overhead rate and absorbed as a part of the cost of the product manufactured. Under direct costing methods, fixed manufacturing costs are handled as **period costs, not as product costs**; i.e., they are listed in the income statement in their entirety as expenses of the period (somewhat like selling and general administrative costs) and are not charged to work-in-process inventory accounts and traced through the finished goods inventory into cost of sales.

The two methods have entirely different concepts regarding what is properly shown as product cost, period cost, gross income, and net income. Naturally they will furnish different dollar amounts for inventory values and net income. Direct costing is discussed under that heading in this section.

BASES USED TO APPLY OVERHEAD TO PRODUCT. Overhead rates may be stated as percentages or as certain amounts per hour, unit, pound, etc. For example, an overhead rate can be stated as 80 percent of direct labor cost or $1.50 per machine hour, or in other ways. The base used to apply overhead to product is the factor at the right, i.e., direct labor cost, machine hours, etc. The amount of overhead to be included in the cost of an individual job, lot, process, etc., is to be computed by multiplying the overhead rate by the direct labor cost of the job, or overhead rate by the machine hours spent on the job, etc., depending upon the base used. Obviously, when the overhead rate is computed, the denominator must be stated in the same terms as the base later to be used in applying overhead to product (see Overhead Rate Formulas and Their Uses in this section).

A variety of **bases** may be used for the application of overhead. The more common ones, all of which are defined and discussed subsequently in this section, are:

1. Direct labor cost
2. Direct labor hours.
3. Machine hours.
4. Units of product.
5. Weight, volume, or other measure of physical output
6. Direct materials cost
7. Prime cost.
8. Sales or market prices.
9. Moving average of cost, hours, or units.

Deciding upon Proper Base. In deciding upon the proper base to use, the primary objective is to select the base which will result in the most accurate application of overhead costs to the products manufactured. Generally speaking, this is the base most closely related to the functions represented by the overhead costs being applied. Thus, if the overhead items in question are predominantly related to the supervision and use of labor, the proper base probably is **direct labor cost or direct labor hours.** If the overhead items are predominantly related to the ownership and operation of machinery, a **machine hour base** may be appropriate. If the overhead relates mainly to the ownership and handling of materials, then **materials cost** may be best.

A secondary objective is to minimize clerical effort and cost. Thus, when two or more different bases provide approximately the same overhead cost application, it is proper to choose the simplest base. Although the relative cost of the various methods is a matter which differs from one company to another, generally speaking the least clerical effort and cost results from using the direct labor cost base, or the materials cost base, and the most effort and cost results from using the

machine hours base. Two or more different methods are likely to apply approximately the same amount of overhead cost when the jobs, lots, products, etc., which pass through the cost center are much alike with regard to the ratio between labor, materials, and overhead costs. The various bases may be used with direct costing or absorption costing, with plant-wide (blanket) or separate departmental or cost center rates, with rates predicated on expected activity, normal activity, or practical capacity, and with rates representing any combination of these or other features which distinguish between overhead rates. Where **standard rates** are used in a standard cost system, the usual bases are standard direct labor cost, standard direct labor hours, and standard machine hours.

Extent of Use. A survey made by the Dayton, Ohio, chapter of the National Association of Accountants, of 86 companies in the Dayton area, shows (NAA Bulletin, vol. 32) that the three most widely used methods for application of overhead among these companies were (1) direct labor cost, (2) direct labor hours, and (3) machine hours, in that order. In compiling these results, the Dayton survey makes no distinction between actual and standard costs.

A more recent study (NAA Research Series No. 32, Accounting for Labor and Labor Related Costs) summarizes company practice in **allocation of indirect labor.** It is not entirely applicable here because (1) it pertains to the problem of overhead distribution rather than overhead application, and (2) it covers only indirect labor rather than the overhead costs as a group. It is relevant to this discussion, however, to point out that the three bases most used (either as the only method of allocation or as one of several methods) by the 45 companies in that study were, in order, from greater to lesser use: (1) direct labor cost, (2) direct labor hours, and (3) machine hours. In this study no distinction was made between actual and standard costs.

Although both of these studies, made years apart, included only a relatively small number of companies, the fact that each shows the same three bases in the same order may be taken as an indication that the most widely used bases for application of manufacturing overhead to product appear to be: first, direct labor cost; second, direct labor hours; and third, machine hours.

ACTIVITY LEVEL ASSUMED FOR ABSORPTION OF FIXED COSTS. In the calculation of the overhead rate, a good deal depends upon the activity level which is assumed. Generally speaking, the greater the assumed activity, the lower the overhead rate will be. This is true because the fixed portion of the overhead costs will be spread more thinly on each direct labor dollar, hour, etc.

Three prevailing points of view are found in industry regarding the appropriate activity level to use in computing overhead rates:

1. **Expected activity:** the activity budgeted for the current year.
2. **Normal activity:** the average activity at which the firm expects to operate over a period sufficiently long to carry through all phases of the usual business cycle. A three- to five-year period is often assumed
3. **Practical capacity:** the maximum capacity which the firm can sustain week after week. Practical capacity is not determined by the ability to sell but rather by the ability to produce, as limited by the scarcity of productive facilities, labor, or materials. Practical capacity can be stated on a one-, two-, or three-shift basis, depending upon company preference. The practical capacity of individual departments can be stated in terms independent of other departments or in such a way as to reveal restrictions posed by the bottleneck department.

Effect upon Product Costs and Net Income. Fig. 3, adapted from Matz–Curry–Frank (Cost Accounting), illustrates the possible effect upon the overhead rate of the different assumptions which may be made regarding the activity level. Based upon the firm's over-all **operating budget,** this machinery department is

Operating Level		Monthly Allowances				
Based on direct labor hours		3,500	4,000	4,500	5,000	5,500
Percentage of capacity		70	80	90	100	110
Acct. No.	Account Title					
01	Indirect Labor	$ 863	$ 900	$ 938	$ 975	$ 1,012
02	Clerical Help	155	160	165	170	175
10	Setup Men	1,045	1,080	1,115	1,150	1,185
14	Rework Operations	100	100	100	100	160
28	Supervision	1,200	1,200	1,200	1,200	1,800
41	Factory Supplies	287	300	312	325	337
44	Overtime Premium	...	...	...	500	550
46	Night Premium	...	...	...	...	50
	Total Controllable	$3,650	$3,740	$3,830	$4,420	$ 5,269
55	Insurance: Fire, etc.	$ 80	$ 80	$ 80	$ 80	$ 80
57	Taxes: State and Local	40	40	40	40	40
63	Depreciation	500	500	500	500	500
	Total Noncontrollable	$ 620	$ 620	$ 620	$ 620	$ 620
71	Maintenance	$1,300	$1,400	$1,500	$1,600	$ 1,865
74	Building Occupancy	850	860	870	880	890
77	Gas, Water, Steam, Air	1,275	1,380	1,485	1,590	1,695
79	General Expenses	625	650	675	700	725
	Total Service Depts.	$4,050	$4,290	$4,530	$4,770	$ 5,175
	Total Indirect Expenses	$8,320	$8,650	$8,980	$9,810	$11,064
Burden rate per direct labor hour:						
If based on actual expectations of 4,500 hours				$1.9955		
If based on normal business conditions of 4,000 hours			$2.1625			
If based on practical capacity of 5,000 hours					$1.962	

Fig. 3. Flexible budget showing overhead rate calculation for a machinery department.

expected to operate at 90 percent of practical capacity during the current year. This level is somewhat higher than can be expected under normal business conditions. Normal activity (3- to 5-year period) is 80 percent. From a production standpoint, however, the department is capable of sustaining the 100 percent level of activity week after week.

If the firm predicates its overhead rate upon the concept of **expected activity** (90 percent), the overhead rate to be used during the year is $1.9955 per direct labor hour (presumably rounded out to $2.00). On the other hand, if the firm

works with the concept of **normal activity** (80 percent), or the concept of **practical capacity** (100 percent), the overhead rate will be $2.1625 per direct labor hour or $1.962 per direct labor hour, respectively, before being rounded out.

For a further discussion of the different activity levels, see section on Manufacturing Overhead and Normal Activity.

Naturally these differences in overhead rates will lead to differences in product cost computations. Since underabsorbed or overabsorbed overhead costs are handled at another point in the **income statement**, however, the differences in overhead rates should not lead to significantly different figures for net income unless inventory levels fluctuate widely.

Measuring the Cost of Idle Capacity. When a firm employs a practical capacity overhead rate, the planned and actual volume variance measures the cost of idle capacity, i.e., the part of fixed manufacturing overhead costs that relates to the productive facilities and organization which, although available for use, are not currently being employed. Those companies using practical capacity overhead rates emphasize this feature as an important advantage of their system. It measures the important managerial cost of idle capacity and reports it separately from the ordinary product costs, thus permitting a more meaningful evaluation of the consequences of imperfectly balancing the ability to produce and the ability to sell.

USE OF MULTIPLE OVERHEAD RATES. Instead of using one plant-wide or blanket rate, the overhead rate may be subdivided into two or more parts. The objective in subdividing the overhead rate is more accurate product costing. The subdivision may be made along one or more of the following lines:

1. Separate rates for each **producing department.**
2. Separate rates for each **cost center.**
3. Separate rates for different **operations** (usually a subdivision of a department).
4. Separate rates for each **product class.**
5. Separate rates for applying the **materials-related** part, the **labor-related** part, and the **facility-related** part of overhead cost.
6. Separate rates for applying the **fixed part of overhead** and the **variable part of overhead.**

Determination of Rate Subdivision. In deciding whether to subdivide the overhead rate and along what lines to make the subdivision, the cost accountant should study carefully both the production process itself and the products manufactured. Where there are important differences in the **nature of the work performed** in different parts of the factory, and where there are important differences among **products** with regard to the time spent in the different parts of the factory, the overhead cost applied to products will be accurate only when departmental, cost center, or operational rates are used or when separate rates are used for the different product lines. Further, when there are important differences among products in the relative importance of **raw materials cost,** an accurate allocation of materials-related overhead costs (such as those of purchasing, receiving, and storing) may call for using a special **supplementary materials-related overhead rate** or for incorporating this effect in separate rates for different product lines. In special situations, similar arguments can be made for the use of separate rates for applying labor-related and facility-related overhead and for fixed and variable portions of overhead, but provision for these costs ordinarily can be made by using departmental, cost center, or operational rates.

An important consideration in setting up the boundaries between different rates (departmental, cost center, or operational) is the segregation of production

activities which are significantly different in cost. It probably would not be worth while, for example, to use separate overhead rates for two departments (cost center or operations) if the rates were \$1.00 per direct labor hour and \$1.01 per direct labor hour. However, if the two rates were significantly different in amount, or if for some reason they could not both be stated in terms of the same base (direct labor hours, machine hours, etc.), then separate rates probably should be used.

Subdivision Along Two or More Lines. Overhead rates may be subdivided simultaneously along two or more lines. For example, a firm could employ an overhead rate structure composed of such elements as the following:

1. A special plant-wide overhead rate based on materials cost, for applying materials-related overhead to jobs.
2. Separate rates for each department based on direct labor cost, for applying departmental overhead to jobs.
3. For some departments, separate rates for cost centers or other subdivisions of the department. These rates could be used to supplement a departmental overhead rate designed to apply only the general departmental expenses. The cost center rates could be based on direct labor hours, machine hours, or possibly some other base.

Practical Limit to Subdivision. There is a wide variety of such combinations which the cost accountant can resort to in his search for the most accurate basis for applying overhead to products. Generally speaking, however, there is a practical limit to the extent of further rate subdivision, i.e., the point at which further subdivision leads to little change in product costs. This limit must be decided individually by each firm after experimentation with different methods and must be based upon such considerations as the following:

1. The need for extreme accuracy in product costing
2. The clerical time and cost involved under the various possible overhead rate structures.

Multiple Rate Combinations. Figs. 4 and 5 demonstrate some of the possible uses of multiple overhead rates. It is assumed that the factory in question manufactures product-line A and product-line B, utilizing two producing departments, and that overhead rates are to be based on expected activity.

In Fig. 5 the cost of each job is affected at least to some degree by the **overhead rate structure** which is used. This is a result, of course, of the different amount of overhead cost which is applied to the job in each case; raw materials and direct labor costs are not affected by the overhead rate structure which is used.

The cost of some jobs is influenced to a greater extent than the cost of others. Job 101, for example, shows the same cost in all cases except Case 5, while Jobs 301 and 401 show different costs for each case. This variation in results is caused by the extent to which an individual job differs from the **average job** with regard to the time spent in each department, the ratios between materials cost, labor cost, labor hours, and machine hours, etc. Job 101, for example, is exactly average in so far as the year's expectations for all jobs is concerned, while the other jobs differ to one degree or another from the year's average. If all jobs were sufficiently similar to the average job, the subdivision of overhead rates would not significantly improve the accuracy of product costs even though several departments were involved in the processing of the product.

In the hypothetical example shown in Fig. 5, the most accurate measurement of cost seems to be provided by Case 4, although Case 2 shows approximately the

	Machining Department	Assembly Department	Both Departments
	Prod. A: 15,000 Machine Hr. Prod. B: 5,000 Machine Hr. Total 20,000 Machine Hr.	Prod. A: 10,000 D.L. Hr. Prod. B: 20,000 D.L. Hr. Total 30,000 D.L. Hr.	Prod. A: \$ 50,000 Dir.Labr. Prod. B: 50,000 Dir.Labr. Total \$100,000 Dir.Labr.
Material, Related Overhead. . .	\$10,000	\$10,000	\$20,000
Labor and Machinery, Related Overhead	50,000	20,000	70,000
Total Overhead	\$60,000	\$30,000	\$ 90,000
Total Raw Material	. . . . .	. . . . .	160,000
Calculation of Overhead Rates:			
Case 1: Blanket Overhead Rate			90% of direct labor
Case 2: Departmental Rates	\$3.00 per machine hr.	\$1.00 per direct labor hr.	
Case 3: Material, Related Secondary Overhead Rate			12 ½% of raw material
Primary Overhead Rate (Plantwide)			70% of direct labor
Case 4: Material, Related Secondary Overhead Rate			12½% of raw material
Primary Rates (Departmental)	\$2.50 per machine hr.	66 ⅔¢ per direct labor hr.	
Case 5: Product A Rate			110% of direct labor
Product B Rate			70% of direct labor

Fig. 4. Calculation of various single and multiple overhead rates.

	Job 101 Product A		Job 201 Product B		Job 301 Product A		Job 401 Product B	
Machine hours (*M* Department)	20 hr.		10 hr.		30 hr.		15 hr.	
Direct labor hours (*A* Department)	30 hr.		40 hr.		20 hr.		50 hr.	
Direct labor	$100.00		$100.00		$ 80.00		$110.00	
Raw materials	$160.00		$160.00		$180.00		$150.00	
Applied Overhead								
Case 1: Blanket rate		$ 90.00		$ 90.00		$ 72.00		$ 99.00
Case 2: *M* Department Overhead	$ 60.00		$ 30.00		$ 90.00		$ 45.00	
A Department Overhead	30.00		40.00		20.00		50.00	
		$ 90.00		$ 70.00		$110.00		$ 95.00
Case 3: Materials Overhead	$ 20.00		$ 20.00		$ 22.50		$ 18.75	
Plantwide Rate	70.00		70.00		56.00		77.00	
		$ 90.00		$ 90.00		$ 78.50		$ 95.75
Case 4: Materials Overhead	$ 20.00		$ 20.00		$ 22.50		$ 18.75	
M Department Overhead	50.00		25.00		75.00		37.50	
A Department Overhead	20.00		26.67		13.33		33.33	
		$ 90.00		$ 71.67		$110.83		$ 89.58
Case 5: Product rate		$110.00		$ 70.00		$ 88.00		$ 77.00

Fig. 5. Calculation of applied overhead cost, using various overhead rate structures in Fig. 4.

same results. The other methods, while perhaps easier for the cost accountant to set up and use, seem to render less accurate results. Perhaps an even more accurate combination of multiple overhead rates could have been conceived for this example. By weighing the various factors existent in this particular example, the cost accountant could conclude that the overhead rate structure given in Case 2 is the best to use because it provides sufficient accuracy at reasonable clerical cost.

Overhead Rate Formulas and Their Uses

THE GENERAL FORMULA. The general formula which is used to calculate the overhead rate is

$$R = \frac{O}{A}$$

where R = overhead rate for the period.
O = total annual or average monthly overhead cost anticipated for the period, assuming the activity level as shown for A.
A = total annual or average monthly activity upon which the overhead rate is to be based. A may be expressed in direct labor dollars, direct labor hours, machine hours, units of output, or in other ways described in detail in subsequent paragraphs. A may relate to the expected activity for the period or to some hypothetical level of activity such as that visualized for normal business conditions or for operation at practical capacity.

R, O, and A may relate to the whole plant (plant-wide or blanket rate) or they may relate only to a subdivision of the plant (such as a department, cost center, or machine), or to a single function or activity carried on within the plant (such as materials handling, labor supervision and administration, or machine setup).

The general formula which is used to apply overhead to product is

$$O_p = R \times A_p$$

where O_p = the amount of overhead to be applied to the product, i.e., the amount of overhead cost to be added together with the raw materials cost and the direct labor cost in compiling the total cost of a job, production lot, process, etc.
R = the overhead rate for the period.
A_p = the total activity involved in manufacturing the product (job, lot, or process). A_p is measured in the same terms as those upon which the overhead rate is based (direct labor dollars, direct labor hours, machine hours, etc.).

Where **multiple overhead rates** are used, the total overhead to be applied to a job, lot, process, etc., is computed by adding together the O_p amounts for the several subdivisions of the plant through which the product passes (see Fig. 5).

DIRECT LABOR DOLLAR FORMULA. Applying overhead as a percentage of the direct labor dollar is one of the oldest methods and still appears to be the most popular base. The percentage is determined by dividing overhead cost by the dollar amount of direct labor, and the overhead is applied by multiplying this percentage by the direct labor cost of each job or line of product. The computation of the rate may be expressed in a formula:

$$\frac{\text{Anticipated overhead cost}}{\text{Anticipated direct labor dollars}} \times 100 = \text{percentage of direct labor cost}$$

The items of the equation may be for the factory as a whole, for each department in the plant, for each cost center, or for some other subdivision of plant activity.

The numerator for overhead and the denominator for direct labor dollars may be expressed in terms of **expected actual, normal, or practical capacity.** By keeping the numerator and denominator on the same basis, the resulting percentages represent, respectively, expected actual, normal, and practical capacity rates. Some feeling has been expressed that the various factors are interchangeable, i.e., that it is feasible and at times reasonable to use the numerator on one basis and the denominator on another; e.g., a percentage of anticipated actual overhead to normal or standard labor. Such a mixture of bases is ordinarily not advisable and should be avoided. One manufacturer of heavy duty machines reports that his plant has developed standards for materials and labor, but owing to certain disturbed conditions, the task of standardizing overhead has been postponed. In the meantime the actual cost is charged to production on the basis of standard labor cost. This concern feels that, while the situation is not ideal, it is better to apply the overhead on the basis of a stable figure such as standard labor cost rather than on a fluctuating basis of actual labor cost. The method adopted may serve during the period of transition from an actual to a standard cost basis. Its adoption, however, in a given case must depend on the nature of the business, the relationship between costs and prices, and the degree and nature of control to be exercised.

Plant-wide Direct Labor Dollar Rates. Assuming that anticipated overhead cost for the year for a certain plant was $258,000, while the anticipated direct labor cost for the same plant amounted to $200,000, the blanket, or plant-wide, overhead rate would be computed as follows:

$$\frac{\$258{,}000}{\$200{,}000} = 129 \text{ percent}$$

In other words, for each dollar of direct labor, there is to be added $1.29 of overhead cost. Thus, if subassembly A-261 requires $400 direct labor, the overhead costed against it is as follows:

Subassembly A-261

Direct labor	$400
Overhead rate	129%
Overhead cost	$516

Departmental Direct Labor Dollar Rates. Arnold (NAA Bulletin, vol. 35) explains how his company develops and uses departmental direct labor dollar overhead rates:

> The data developed here applies to a typical small-parts manufacturing and assembly plant. The regular product line includes some two hundred sales items. The plant is operated under a well-established wage incentive plan covering production labor and a large segment of indirect labor, such as janitor service and plant maintenance work. . . .
>
> The overhead rates in their final form are applied to the direct labor dollars required to manufacture the product. However, it will be seen that their development stems from several indices of activity other than that measured by the direct labor dollar. On any given part, however, there is a relationship between the number of labor dollars paid and the number of units produced. Technological improvements and wage rate changes may alter the basic number of dollars required to produce a part, but overhead rates are easily adjusted to compensate for these changes. As the direct labor content lowers, the burden rate may rise, but it is the final unit cost which counts. If increased burden does reflect technological progress, a low direct labor cost coupled with a high burden increment may well produce lower costs than a high direct labor cost coupled with a low burden increment.

Fig. 6 has been adapted from Arnold's illustration. The final departmental overhead rates are shown in the second column, "Product Overhead Rates." These figures were computed by dividing the total product overhead (Col. 3) by total direct labor on products (Col. 1). In this instance the problem of developing departmental overhead rates was compounded by the fact that many manufacturing overhead centers also were performing nonproduct operations (construction of facilities, research and experiments, etc.) to which departmental overhead was applied, using special overhead rates (Col. 11) which were different from those used for product costing.

The steps involved in developing the departmental direct labor dollar rates in Fig. 6 are as follows:

1. Make budget estimates of the **direct overhead** for the year for each manufacturing overhead center (production departments). These are shown in Col. 4.
2. Make budget estimates of the direct costs of **service departments** and of **general factory** expenses. This step is not shown in Fig. 6.
3. Allocate the budgeted expenses of **service departments** and **general factory** costs to the manufacturing overhead centers (production departments), utilizing logical factors relating to the services performed. This is done in Cols. 4 through 9 and Cols. 12 and 13. (In many cases it is desirable to allocate some part of the service department overhead to other service departments, as explained in the section on Distribution of Manufacturing Overhead.)
4. In order to secure special overhead rates for costing nonproduct operations, such as construction of own facilities and conduct of experiments, a subtotal is obtained (Col. 10) relating only to overhead items deemed eligible for this treatment. The special nonproduct overhead rates shown in Col. 11 are computed by dividing Col. 10 by the total of direct labor plus labor expended on nonproduct operations. The total of these two labor cost figures is not shown in Fig. 6.
5. Deduct the standard overhead for estimated nonproduct operations. These figures, shown in Col. 14, are obtained by multiplying budgeted labor on nonproduct operations by the special overhead rates shown in Col. 11. Steps 4 and 5 will be necessary only when the plant has the problem referred to at the beginning of Step 4.
6. Determine the **total direct and allocated product overhead** for each manufacturing overhead center by adding Cols. 4, 5, 6, 7, 8, 9, 12, and 13 and subtracting Col. 14. This total appears in Col. 3.
7. Divide the total product overhead (Col. 3) by the budgeted total direct labor on products (Col. 1) to secure the departmental (manufacturing overhead center) **direct labor dollar rates.**

The use of departmental direct labor dollar rates in costing a product is shown in Fig. 7, which uses Arnold's rates on a cost card. The rate used are those developed in Fig. 6, rounded to the nearest whole percentage. Materials cost and other charges have not yet been posted to the cost card.

Departmental vs. Plant-wide Rates. If a blanket, or plant-wide, rate were used in the factory rates represented in Fig. 6, it would be 197.6 percent of direct labor cost, as shown at the bottom of Col. 2. Fig. 7 shows a manufacturing overhead cost of $1,650.50 for a particular job, using the departmental overhead rates developed in Fig. 6. In contrast, the use of a blanket rate of 198 percent would result in a manufacturing overhead cost of $1,168.20 (590 × 198%) for this job. Thus, where different lines of product are manufactured, requiring different processing times in several departments engaged in different types of activity, blanket rates may not yield accurate overhead costs.

Overhead Manufacturing Centers	Total Direct Labor on Products	Product Overhead Rates (Percent of Direct Labor)	Total Product Overhead	Charged Directl
	(1)	(2)	(3)	(4)
Press	402	357.76	1,438	665
General Machining	1,434	240.03	3,442	1,191
Automatic Screw Machine	377	349.87	1,319	660
Finishing, lacquer	206	318.93	657	222
Finishing, buff and plate	535	229.53	1,228	378
Assembly	2,402	144.92	3,481	754
Product Quality	503	201.79	1,015	391
Facilities and Service	321	176.64	567	742
Product Development and Design Engineering	465	132.90	618	586
Special Products *A*	520	172.12	895	288
Special Products *B*	1,170	154.70	1,810	508
Total: Mfg. Overhead Centers	8,335	197.60	16,470	6,385

Fig. 6. Development of departmental

Advantages and Disadvantages. The direct labor dollar method is easy to use, economical, and simple, since all requisite data are available without further record keeping; i.e., the total of direct labor cost is available from the payroll summary. The important objections to this method arise from the following facts:

1. It ignores the contribution of value to the product by factors of production other than direct labor, e.g., machinery. In some departments it is not labor but expensive machinery that represents the prime production factor.
2. It rests on a dollar expenditure basis, which is not necessarily a proper measure of the contribution of value because many overhead expenses such as taxes, property insurance, depreciation, etc., are functions of time.
3. It charges operations performed by high-rate operators with proportionately more overhead than those operations performed by low-rate operators. This results in a faulty application of overhead to product where two or more operators in a specific department perform the same operation on different jobs or classes of product but are paid varying rates per hour. If the varying rates per hour reflect differences in the speed or quality of work, it may be proper to apply proportionately different amounts of overhead cost.

These objections can be overcome where labor rates are uniform in each department and where direct labor is the main productive element.

DIRECT LABOR HOUR FORMULA. Applying overhead as a rate per direct labor hour involves a determination of the relationship between the amount of overhead cost to be applied and number of direct labor hours. Overhead is costed to the job or process by multiplying this rate by the number of direct labor

	Apportioned on the basis of:				Subtotal—Overhead Applicable to All Types of Labor		Apportioned on Product Labor		
Overhead Center Payroll	Productive Floor Space	Assigned Assets	Use Factor	Services Rendered	Amount	Rate (%)	All Mfg. Overhead Centers	All Overhead Centers Except Engineering	Deduct Standard Overhead on Nonproduct Labor
(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
114	146	36	20	221	1,202	294.61	222	32	18 Cr
425	278	61	67	615	2,637	176.86	790	116	101 Cr.
138	102	45	29	113	1,087	286 81	208	30	6 Cr.
51	106	11	45	102	537	255.71	113	17	10 Cr.
128	132	15	93	166	912	166.42	295	43	22 Cr.
536	431	19	3	237	1,980	81.82	1,323	193	15 Cr.
134	151	1	1	29	707	138.63	277	41	10 Cr.
360	259	26	7	23	1,417	113.54	177	26	1,053 Cr.
257	194	9	2	27	1,075	77.84	256	..	713 Cr.
128	35	1	5	110	567	109.04	286	42	..
296	100	1	6	160	1,071	91.54	645	94	..
2,567	1,934	225	278	1,803	13,192	128.26	4,592	634	1,948 Cr.

direct labor dollar rates (figures in thousands).

hours as shown by reports. The computation of the rate may be expressed in a formula:

$$\frac{\text{Anticipated overhead cost}}{\text{Anticipated direct labor hours}} = \text{rate per direct labor hour}$$

The items of the expression may be for expected, normal, or practical capacity. Also, the items of the equation may be for the factory as a whole, for each department in the plant, for each cost center, or for some other subdivision of plant activity. For example, assuming that the anticipated overhead cost for the year for a certain plant was $258,000, while the total anticipated direct labor hours amounted to 368,500, then the overhead rate per direct labor hour in the department is $0.70, obtained by dividing $258,000 by 368,500 hours. That is, for each hour of direct labor, there is to be added $0.70 of overhead cost. If subassembly A-261 required 710 hours of direct labor, the overhead costed against this item is as follows:

SUBASSEMBLY A-261

Direct labor hours	710
Overhead rate per hour	$ 0.70
Overhead cost	$497

Departmental Direct Labor Hour Rates. Fig. 8 uses anticipated actual costs in computing direct labor hour rates on a departmental basis for a concern manu-

Cost Card

Style No.________

Description Cost Per

Order No.										
Date										
Material	Quan.		Price	Amount		Quan.		Price	Amount	
Total Material										
Labor and Overhead	Labor		Per cent	Overhead		Labor		Per cent	Overhead	
Press	$ 70	00	358	$ 250	60					
General Machining	100	00	240	240	00					
Automatic Screw	200	00	350	700	00					
Finishing, lacquer	50	00	319	159	50					
Finishing, buff and plate	50	00	230	115	00					
Assembly	100	00	145	145	00					
Product Quality	20	00	202	40	40					
Facilities and Service			177							
Product Development			133							
Sp. Products "A"			172							
Sp Products "B"			155							
Total Labor and Overhead	$590	00		$1,650	50					
Summary Material										
Labor										
Overhead										
Total Factory Costs										
Commercial Cost										
Rate										
Amount										
Total Cost										
Add in Deductions										
Total Cost and Sales Deductions										
Selling Price										
Profit										

Fig. 7. Cost card showing departmental overhead application.

facturing uniforms. The general overhead rate cannot be determined for all departments by dividing the departmental costs by the units of output in the factory. The overhead rates for the cutting room, trimming department, and bullion department may be determined by the **labor cost method,** since the employees work substantially with the same equipment under similar conditions in these departments. Furthermore, the wages are fairly uniform in each department, and

all the work is done by hand. In the coat and pants shop, the production center method can be used because there are two classes of work performed, machine work and bench work. The **labor hour method** should be used for both machine and benchwork production centers, since time is a dominant factor in both cases, wages are mostly at piecework rates (and therefore not uniform), and all employees work under similar conditions.

Fig. 9 shows the **cost card** used to accumulate costs by part or style of uniform, for using departmental rates (C) developed in Fig. 8. Actual rates are applied.

Plant-wide Labor Hour Rates. A plant-wide, or blanket, rate using the same illustration is determined as follows:

$$\frac{\text{Anticipated overhead cost for whole plant}}{\text{Anticipated total direct labor hours for whole plant}} = \frac{\$8{,}625}{8{,}800} = \$0.98 \text{ per hour}$$

But since the plant manufactures a variety of uniforms, caps, etc., conditions of manufacture vary from one department to another, and a blanket rate does not provide the accuracy offered by departmental rates.

Advantages and Disadvantages of Labor Hour Rates. The direct labor hour method is easy to use and is an ideal base for application of overhead where labor operations constitute the central factor in production. The overhead of an organization is a dollar measure of the cost of providing facilities for efficient production at a bench or machine. The more important elements of this overhead, excluding indirect labor, are based on lapse of time as a common element (e.g., power, depreciation, supervision, insurance, rent, etc.). The direct labor hour method makes use of the time factor, and thus it answers a major objection of the direct labor dollar method, since operations taking the same time are costed with the same overhead, though the operators may be receiving different rates of pay. When the different rates of pay accurately reflect different skills or different speeds of operation, however, it may be proper to charge more overhead for the higher paid direct labor, and thus the direct labor dollar base may be proper.

A minor objection arises from the fact that additional information must be compiled and analyzed, i.e., the number of direct labor hours by departments and products. The data are already available, however, on labor **time reports.** This method shares with the labor dollar method the disadvantage that it ignores the contribution of value to the product by factors other than direct labor. For example, it may be inaccurate to cost overhead on a departmental direct labor hour basis for a machine shop composed of turret lathes, drill presses, and automatic screw machines. Also, it may be inaccurate to cost materials handling overhead on a direct labor hour basis.

MACHINE HOUR FORMULA. Applying overhead as a rate per machine hour requires finding the ratio between the amount of overhead cost to be applied and the number of machine hours. Overhead is then costed to job or process by multiplying this rate by the number of machine hours involved in a specific operation. The computation of the rate may be expressed as a formula:

$$\frac{\text{Anticipated overhead cost}}{\text{Anticipated machine hours}} = \text{rate per machine hour}$$

As with other overhead rates, the computation may be on the basis of actual expectations, normal activity, or practical capacity for the coming year. The

	Basis of Distribution	Total	Stores	Machine Shop
Floor Space (sq. ft.)		33,060	3,990	300
Value of Machinery		$10,000		$500
Number of Workmen		243	2	1
Number of Connected H P		30		3
Number of Electric Lamps		100	4	2
Amount of Production				
Anticipated Indirect Costs				
Supervision	Number of workers	$2.000.00	$ 16.00	$ 8.00
Foremanship	Actual	1,500.00		
Indirect Labor	Floor space	500.00	60 50	5 00
Depreciation, Machinery	Value of machinery	300 00		15 00
Taxes, Machinery	Value of machinery	300.00		15 00
Rent	Floor space	2,000.00	242.00	20 00
Insurance, Machinery	Value of machinery	200.00		10 00
Liability Insurance	Number of workers	100.00	.80	40
Repairs (Labor and Material)	Actual	250 00		25 00
Stationery and Printing	Arbitrary	400 00	50.00	5 00
Miscellaneous Factory Costs	Arbitrary	175.00	20.00	5 00
Heat	Floor space	400 00	48.40	4 00
Power	Number of connected H.P.	300.00		30 00
Light	Number of bulbs	200.00	8.00	4.00
Actual Amount Used per Requisition			$445.70	
Value of Machinery				$146 40
Amount of Production				
Floor Space				
Amount of Production				
A: Total Cost		$8.625.00		
B: Productive Labor Hours per Department				
C: Overhead Rate per Productive Hour (A ÷ B)				

Fig. 8. Development of departmental

rate also may be computed for all machinery utilized in the plant (plant-wide, or blanket, rate), for the machinery utilized in a particular department (departmental rate), or for a cost center composed of a specific machine or a group of machines which are practically identical in cost and operation (cost center rate).

Plant-wide Machine Hour Rate. A blanket, or plant-wide, machine hour rate is seldom found in industry. A single rate of this type may be used when the manufacturing process utilizes only one type of machinery. For example, a firm may be in the business of weaving special fabrics, utilizing a bank of similar weaving machines. If it is estimated that the weaving machines will be operated a total of 15,000 machine hours during the coming year, with an estimated overhead cost of $33,000, the machine hour rate is $2.20 (found by dividing $33,000 by 15,000 hours). That is, for each hour of weaving, $2.20 is to be added for

Bush'l'g Dept.	Ship. Dept.	Inspection and Packing	Cutting Room	Trimming Dept.	Coat Shop	Pants Shop	Bullion Dept.	Cap Dept.	Office
400	2,800	600	5,700	1,540	3,580	3,000	400	600	5,150
$100	$200		$100		$6,000	$3,000	$100		
5	3	4	22	4	120	75	5	2	
1	2		3		10	11			
2	4	4	15	5	30	20	2	2	10
			9,200 (suits)	9,200 (suits)	6,000	3,200	2,000		
$ 40.00	$ 24.00	$ 32.00	$ 180.00	$ 32.00	$ 996.00	$ 616.00	$ 40.00	$ 16.00	
120.00			200.00	200.00	400 00	400.00	100.00	80.00	
6 00	42.00	10.00	86.00	23.00	128.50	45.50	6.00	10.00	$ 77.50
3 00	6.00		3.00		180.00	90.00	3.00		
3 00	6.00		3.00		180.00	90.00	3.00		
24.00	168.00	40.00	344.00	92.00	514.00	182.00	24.00	40.00	310.00
2.00	4.00		2.00		120.00	60.00	2.00		
2.00	1.20	1.60	9.00	1.60	49.80	30.80	2.00	.80	
30.00			25.00	5.00	70.00	50.00	10.00	5.00	30.00
5.00	50.00	25.00	30.00	20.00	70.00	70.00	20.00	25.00	30.00
3 00	25.00	15.00	10.00	12.00	30.00	30.00	10.00	15.00	
4.80	33.60	8.00	68.80	18.40	102.80	36.40	4.80	8.00	62.00
10.00	20.00		30.00		100.00	110.00			
4.00	8.00	8.00	30.00	10.00	60.00	40.00	4.00	4.00	20.00
25.70			75.00	50.00	175.00	100.00	15.00	5.00	
1.46	2.92		1.46		92.25	46.85	1.46		
$283.96			113.58	28.40	85.19	56.79			
....	$390.72	11.72	113.31	31.26	168.00	58.61	7.82		
....	....	$151.32	52.97	15.13	45.40	30.26	7.56		
....	....	....	$1,377.12	$538.79	$3,566.94	$2,143.21	$260.64	$208.80	$529.50
....	....	....	1,000	400	4,000	3,000	200	200	
....	....	....	$1.38	$1.35	$.89	$.71	$1.30	$1.04	

direct labor hour rates.

overhead cost. If a job, No. 127, required 45 minutes of weaving, the overhead costed to the job would be as follows:

Job No. 127	
Machine time, weaving	0.75 hours
Overhead per machine hour	$2.20
Overhead cost	$1.65

Departmental Machine Hour Rates. Departmental machine hour rates are computed in practically the same fashion as departmental direct labor hour rates (see Fig. 8). The only difference is that the manufacturing activity of the producing departments is measured in machine hours instead of direct labor hours (productive labor hours per department in Fig. 8). Thus machine hours would

DATE ____________ 19__ **COST CARD**
DESCRIPTION ____________________ NO ______
NAME OF PART ____________________

PLANT DEPARTMENTS	HOURLY OVERHEAD RATE	PRODUCTION COST						DEPARTMENT TOTALS		GRAND TOTAL	
		MATERIAL		LABOR		FACTORY EXP					
				HRS							
Cutting Room											
Trim Dep't											
Coat Shop											
Pants Shop											
Bullion Dep't											
Cap Dep't											

Fig. 9. Cost card for using departmental hourly rates in applying overhead.

be used instead of direct labor hours in budgeting the costs for the year, in calculating the overhead rate, and in applying overhead to product.

With regard to the use of departmental machine hour rates, March (Cost Accounting) says:

In a department where the machine overhead is a large factor, the use of a departmental rate per machine-hour is sometimes recommended. Only in unusual circumstances, however, is the machine-hour a suitable base for a departmental burden rate. It may be used satisfactorily where all the work points in a department are similar machines, but then the department is a machine [cost] center and the departmental rate would be in effect a machine rate.

Cost Center Machine Hour Rates. A cost center usually is a subdivision of a department. Cost center rates are used in order to provide a more accurate allocation of overhead costs to the product.

March (Cost Accounting) explains a **cost center** as follows:

A burden center or cost center is a segment of a plant, or in some cases an entire plant, which is treated as a functional unit for the purpose of applying process overhead. It may be a single work point, such as a machine, a group of work points smaller than a department, a processing department, or an entire plant. A burden rate is computed for each burden center to use in applying overhead to work processed in that center.

(For a detailed discussion of cost centers see Cost Center Overhead Rates in this section.)

There are three steps in computing cost center machine hour rates:

1. Determination of the estimated overhead costs for the period, by departments. This may take the form of a budget, set up in the form of a **cost distribution sheet** (Fig. 10). The amounts given in Fig. 10 are the expected actual expenses for the ensuing year, and the overhead rates will therefore be for expected actual conditions. If the firm wants to use normal overhead rates, or rates based upon assumed conditions of practical capacity, then the figures shown in

For the year: 19___

Overhead Account			Producing Departments			Service Departments				
Code	Name	Grand Total	Dept. 51 Forge Shop	Dept. 52 Machine Shop	Dept. 53 Assembly	Dept. 65 Storeroom	Dept. 66 Toolroom	Dept. 67 Engineering	Dept. 68 Cost and Payroll	Dept. 69 Supervision and General
7301	Fuel	$ 9,600	$ 9,600							
7302	Spoilage	1,200	480	$ 400	$ 320					
7303	Heat	960	360	240	180	$ 84	$ 36	$ 48	$ 12	
7304	Light	2,139	690	460	345	460	69	92	23	
7305	Power	5,760	2,604	2,148	480	230	58	120	120	
7306	Water	288								$ 288
7307	Compensation Insurance	1,581	634	320	382	54	30	57	28	46
7308	Auto Repairs	144								144
7309	Auto Supplies	360								360
7310	Indirect Factory Supplies	40,602	20,400	12,000	5,316	720	432	1,146	504	84
7311	Janitorial Supplies	180								180
7313	Maintenance Materials, Equipment	1,080	540	324	216					
7314	Maintenance Materials, Building	600	192	132	96	132	18	24	6	
7315	Maintenance Labor, Equipment	5,400	2,700	1,620	1,080					
7316	Maintenance Labor, Building	1,800	576	396	288	396	54	72	18	
7317	Material Handlers	9,120				9,120				
7318	Toolroom Operators and Attendants	2,256					2,256			
7319	Other Indirect Labor	33,600	12,444	9,960	11,196					
7320	Superintendent	4,800								4,800
7321	Foremen	18,000	4,800	4,800	4,800		3,600			
7322	Storekeeper and Attendants	7,200				7,200				
7323	Engineers and Draftsmen	11,400						11,400		
7324	Cost and Payroll Employees	5,640							5,640	
7325	Watchmen, Janitors, and Elevator Operators	3,192								3,192
7326	Truck Drivers	1,200								1,200
7330	Medical Fees	1,200								1,200
7331	Machine Royalty Rentals	55,200	28,800	14,400	12,000					
7332	Patents Amortization	2,040	960	720	360					
7340	Depreciation, Building	2,232	720	480	360	480	72	96	24	
7341	Depreciation, Machinery	21,600	8,640	4,320	3,240	1,080	2,160	1,728	432	
7342	Depreciation, Office Equipment	360				120			240	
7343	Depreciation, Automobiles	600								600
7350	Insurance, Buildings	1,116	360	240	180	240	36	48	12	
7351	Insurance, Machinery	2,400	960	480	360	120	240	192	48	
7352	Insurance, Office Equipment	36				12			24	
7353	Insurance, Automobiles	240								240
7354	Insurance, Inventories	1,800				1,800				
7360	Taxes, Building	1,674	540	360	270	360	54	72	18	
7361	Taxes, Machinery	4,200	1,680	840	630	210	420	336	84	
	Totals	$262,800	$98,680	$54,640	$42,099	$22,848	$ 9,535	$15,431	$ 7,233	$12,334

Fig. 10. Departmental overhead budget.

the cost distribution sheet necessarily would be different, reflecting these different operating conditions.

2. Regrouping of these items into two classes:
   a. Specific charges to each machine, such as power, maintenance, and depreciation.
   b. Indirect costs which must be allocated to each machine, based on floor space, machine value, etc. This group includes costs such as heat and light, other general service costs such as indirect supplies and labor not otherwise handled, supervision, and engineering.
3. Machine costs, direct and prorated, are combined to obtain total overhead expense to operate each machine during the year. The machine rate is derived by dividing this total by the number of hours of operation. This is shown in Fig. 11.

The estimated hours may take into account the time for **setups**, or in some cases separate rates may be determined for setup and for running time.

Figs. 10 and 11 are adapted from Van Sickle (Cost Accounting). The references in Fig. 11 are to the following bases of distribution:

(a) Meters or horsepower rating of motors.
(b) Statistical record.
(c) Equipment ledger record.
(d) Machine valuation.
(e) Radiation surface.
(f) Floor space area.
(g) Direct labor hours work in each cost center.

The numbers in the columnar headings in Fig. 11 refer to individual machines.

Overhead is costed to the product through the machine rates obtained in Fig. 11. For example:

Overhead Cost, Job 4313

Machine Number	Hours Required	Machine Rate	Overhead Cost
510	2	$38.73	$ 77.46
511	3	11.05	33.15
512	3	5.87	17.61
520	2	26.69	53.38
531	5	13 91	69.55
	Total Overhead, Job 4313		$251.15

Comparison of Methods. When used under proper conditions, the cost center machine hour rate method results in a more accurate application of overhead to products than is possible under methods based on labor, departmental or otherwise. On this point Domenick (NAA Bulletin, vol. 38) says:

In the typical forging process . . . it will be noted that the man hours required are greater than the machine hours. This relationship will vary for each forging. Elements such as the material content, tooling cost, and consequently the selling price, also have no uniform relationship to the direct labor content. For this reason, as stated earlier in this paper, the application of a fixed rate of overhead to the direct labor cost to produce results is a very serious misstatement of conditions as they exist. Our typical process priced under each method would appear as in Fig. 12. The results indicate that burden applied to labor on an over-all plant rate is $0.3324 per unit as compared with the figure of $0.3930 as computed on machine hour rates. On other parts, the over-all rate method might be the higher. There can be no doubt that the machine center method reflects the more accurate cost, since the overhead rates used

Code No.	Account and Name	Total Overhead Expense	510	511	512	520	530	531
	Direct Machine Charges:							
7301	Fuel (a)							
7305	Power (a)							
7313	Maintenance Materials, Equipment (b)							
7315	Maintenance Labor, Equipment (b)							
7331	Machine Royalty, Rentals (b)							
7332	Patents Amortization (b)							
7341	Depreciation, Machinery (c)							
7351	Insurance, Machinery (d)							
7361	Taxes, Machinery (d)							
	Total Direct Machine Charges	$ 99,702	$47,666	$ 5,805	$ 3,013	$24,852	$ 9,183	$ 9,183
	Building Costs:							
7303	Heat (e)							
7304	Light (f)							
7314	Maintenance Materials, Building (f)							
7316	Maintenance Labor, Building (f)							
7340	Depreciation, Building (f)							
7350	Insurance, Building (f)							
7360	Taxes, Building (f)							
	Total Building Cost	$ 7,465	$ 1,719	$ 1,146	$ 573	$ 2,308	$ 860	$ 859
	General and Service Costs:							
7302	Spoilage (g)	$ 1,200						
7307	Compensating Insurance (g)	1,336						
7310	Indirect Factory Supplies (g)	37,716						
7319	Other Indirect Labor (g)	33,600						
7321	Foreman (g)	14,400						
7365	Storesroom Expense (g)	22,848						
7366	Toolroom Expense (g)	9,535						
7367	Engineering Expense (g)	15,431						
7368	Cost and Payroll Expense (g)	7,233						
7369	Supervision and General Expense (g)	12,334						
	Total General and Service Costs	$155,633	$43,577	$21,789	$ 9,388	$34,239	$23,345	$23,345
	Total Annual Machine Charges	$262,800	$92,962	$28,740	$12,924	$61,399	$33,388	$33,387
	Annual Machine Hours (Estimated)		2,400	2,600	2,200	2,300	2,400	2,400
	Machine Hour Rate		$ 38.73	$ 11.05	$ 5.87	$ 26.69	$ 13.91	$ 13.91

Fig. 11. Computation of machine hour rates.

are indicative of a much higher degree of refinement and were based on studies of actual costs incurred to operate each type and size of equipment. It is obvious, therefore, that the distortions similar to the example above can have a serious and possibly a disastrous consequence in establishing selling prices. In this instance, the part could have been quoted and even sold at $0.0606 per piece less than the actual cost to be incurred.

In summarizing, machine center overhead costing merely represents the refinement of costing and enables cost accountants to more accurately state the overhead content of a given part, as compared to an over-all plant rate or even departmental rates. A system of this type is valuable where a number of vastly different types and sizes of equipment are used to produce a given part. It is obvious that, in a plant in which very little machinery is used or all is of the same type and size, this system might yield no valuable results.

UNIT DATA

Operation Number	Labor Cost			Machine Hr.	Burden on Labor @ 550%	Machine Center Method	
	Man Hours	Rate/Hr.	Standard Amount			Rate per Machine Hr.	Standard Amount
10–1	.0033	$1.75	$.0058	.0033	$.0319	$10.00	$.0030
10–2	.0033	1.70	.0056	...	.0308		
30	.0050	1.90	.0095	.0050	0523	15 00	.0750
40	0050	1.95	.0098	.0050	.0539	8 00	.0400
50	0050	2.20	.0110	.0050	.0605	25 00	.1250
60	.0050	2.00	.0100	0050	.0550	12.00	.0600
70–2	.0018	1.80	.0032	...	.0176		
70–1	0009	1 85	.0017	0018	.0094	19.00	.0342
80	.0014	1 75	0025	0014	.0138	15.00	.0210
90	.0008	1 65	.0013	0008	0072	6.00	.0048
Total	0315		$.0604	.0273	$.3324		$.3930

Fig. 12. Comparison of machine hour with labor based methods.

Advantages and Disadvantages of Machine Hour Rates. Where machinery is the main factor in production, the machine hour method constitutes the best way to apply overhead. The basic reasons for this have been stated by Van Sickle (Cost Accounting):

1. From the cost accounting point of view, it affords the most accurate method of allocating overhead expenses to each job.
2. From the engineering point of view, it provides an ideal method for estimating the cost of a job on a specification and route sheet with a high degree of accuracy.
3. From the marketing point of view, it makes it possible for the sales engineer to quote more accurate estimated selling prices for jobs.
4. From the management point of view, it involves the use of an overhead costing method which is scientific, logical, and theoretically sound, in addition to being practical in its use. The management, therefore, can depend upon cost reports to show accurate costs, and it can feel certain that the price quotations to customers are not grossly understated or overstated, thus avoiding either operating losses or the failure to obtain jobs. From the management point of view, it also provides a basis for the measurement of the monthly cost of idle machines.

Note that this method uses time as a base in applying overhead cost. It possesses special advantage over other methods where one operator tends several machines (e.g., in weaving), or where several operators are required for each machine (e.g., in printing). Finally, by adding the rate paid the operator to the overhead rate for the machine, a cost center rate is easily and simply obtained.

The important objections to the machine hour method are as follows:

1. Additional information, not otherwise needed, must be provided in detail; i.e., machine times for each operation. This increases the cost of the accounting procedure, and hence some concerns do not find it practicable to use a machine hour rate.
2. By its very nature this method precludes use of a **blanket rate.** Individual or group machine rates must be used, thus increasing the detailed cost work.
3. The machine hour method is not universally applicable; it can be used only for costing those operations performed by machinery. Many concerns find it possible to use direct labor rates uniformly throughout the plant; relatively few find it possible to use only machine hour rates; other types of rates must be used in combination with them.

UNIT OF PRODUCT FORMULA. Application of overhead on the basis of the number of units of product manufactured during the period is the simplest and most direct method for costing overhead. The overhead rate is obtained by dividing the amount of overhead by the units of product. Expressed as a formula, it is:

$$\frac{\text{Anticipated overhead cost}}{\text{Anticipated number of units of product}} = \text{overhead cost per unit}$$

As in previous cases, the terms of expression may be expected actual, normal, or practical capacity; also, they may be for the factory as a whole, by departments, by cost centers, or for some other subdivision of plant activity. For example, if actual overhead cost for an assembly department is expected to be \$25,800, while the number of assemblies completed is expected to be 5,000, then the overhead cost per unit is \$5.16 (that is, \$25,800 divided by 5000).

The shoe industry affords an example of the application of overhead by the unit of product method (overhead per pair of shoes), in this case including commercial overhead. It should be noted, however, that no commercial overhead is permitted to find its way into inventory values.

Advantages and Disadvantages of Unit of Product Rate. The unit of product method for applying overhead is the simplest and most direct. Its usefulness, however, is limited to those situations where only one product, or a few closely related products possessing a common denominator such as weight, are manufactured. Where no natural common denominator exists, one may be devised by resorting to a point basis or some other weighting factor. If this fails, the method breaks down. Even when a common denominator can be found, this method will not be accurate unless actual overhead costs are closely related to the common denominator which is chosen.

METHODS BASED ON MEASURE OF PHYSICAL OUTPUT. There are several variations in the unit of output method, employing different ways of measuring output as adapted to the character of the industry. With these various methods, output (and therefore overhead application) may be based on ounces, pounds, tons, gallons, cubic feet, bushels, barrels, statistical points, etc. The com-

putation and use of the overhead rate for these various methods is practically the same as for the unit of output method. The formula for computing the rate is:

$$\frac{\text{Anticipated overhead cost}}{\text{Anticipated output (measured by weight, volume, etc.)}} = \text{overhead cost per unit of output}$$

Weight Basis. Weight is a basis for applying overhead in mining and in certain other industries where the natural unit of output is tons, pounds, etc. This method is also used by firms manufacturing a single line of products sold in various sized containers easily differentiated by weight. Thus, a small firm manufacturing a cosmetic sold in various sized containers could compute its overhead rate as follows: overhead budgeted for the year, $125,000 divided by output budgeted for the year, 250,000 pounds equals overhead rate of $0.50 per pound. In producing its product, overhead would be charged to different batches of production at the rate of $0.50 per pound. Thus the following costs could be shown for a particular batch of production composed of 1,000 pounds packaged in six hundred 1-pound jars and eight hundred 8-ounce jars. The difference in the cost per pound of the two finished products presumably is caused by different costs for the jars and for filling and handling the jars.

	Total	1-lb. Jars (600)	8-oz. Jars (800)
Materials (direct cost from requisition slips)	$1,000	590	410
Labor (direct cost from time cards)	600	290	310
Overhead (applied, $0.50 per lb.)	500	300	200
Total Cost	$2,100	1,180	920
Cost per jar		$1.97	$1.15
Cost per lb.	$2.10	1.97	2.30

Volume Basis. Volume as a basis for applying overhead is sometimes used by water companies, pipe line distributors, farmers, petroleum manufacturers, and in other industries where output characteristically is measured in gallons, barrels, bushels, etc. This method is also found when a firm manufactures a single product packaged in various sized containers easily differentiated by volume. The procedure is the same as that shown for methods based on weight.

Statistical Point Basis. Where weight or volume does not provide a common denominator, there is the possibility of using a point base, derived by assigning a statistical point value to each product made.

Application of overhead costs by output on the basis of statistical points may be illustrated by reference to the manufacture of mattresses. In this case there is a standard product with no important grade differences. Unit costs for overhead in total and by departments are obtained in each case by dividing the cost by the number produced. These operation or department costs are then allocated to the different styles of product on a point basis determined by an analysis of material, labor, and factory cost conditions.

Use in Applying Materials Handling Costs. A specialized use of an overhead rate based on weight or volume is sometimes found when a firm employs a separate **secondary overhead rate** for applying materials-related overhead costs to product. For example, a firm may employ an overhead rate structure composed of the following elements:

1. Departmental overhead rates based on direct labor dollars, labor hours, or machine hours for applying all overhead costs except those related to the purchase, receipt, storage, and handling of materials.

2. **A plant-wide overhead rate based on the weight or volume of materials for applying the materials-related overhead.**

The first group of overhead rates would be computed in the ordinary way except that the numerator of the formula would not include any of the anticipated materials-related overhead costs of the period. The plant-wide materials handling overhead rate would be computed as follows:

$$\frac{\text{Anticipated materials handling overhead cost}}{\text{Anticipated weight (or volume) of materials}} = \text{overhead cost per lb., per gal., etc.}$$

When this type of an overhead rate structure is used, the overhead cost to be charged to a job, lot, process, etc., can be computed as follows:

Job 473K

Department	Direct Labor Hours	Overhead Rate	Overhead Cost Applied
Mixing	10	\$1.00 per D.L.H.	\$10.00
Blending	15	2.00 per D.L.H.	30.00
Packing	5	2.50 per D.L.H.	12.50
Total departmental overhead cost applied			\$52.50
Materials handling overhead:			
Weight of product × materials handling rate = 300 lb. × \$.05 per lb.			15.00
Total overhead applied to Job 473K			\$67.50

The use of separate rates for applying materials-related overhead is discussed more fully in this section under Separate Rates for Production Factors.

Advantages and Disadvantages of Rates Based on Physical Output. Overhead rates based on weight, volume, statistical points, or other indicators of physical output have the same advantages and disadvantages as the unit of product method. Under the proper conditions for their use, they are simple and effective. They can be used, however, only when output can be measured in one common denominator (pounds, tons, gallons, bushels, etc.), and even then they are accurate only when actual overhead costs are closely related to the physical volume of product.

MATERIALS COST FORMULA. Overhead may be distributed to product on the basis of the cost of direct materials consumed in producing the product. The formula for computing such a rate is:

$$\frac{\text{Anticipated overhead cost}}{\text{Anticipated direct materials cost}} = \text{percentage of overhead per direct material dollar}$$

The expression may be in terms of expected, normal, or practical capacity. It can be used on a departmental or on a blanket basis. It does not, however, have wide usefulness except as a base for a separate secondary overhead rate for applying **materials burden** (i.e., materials-related overhead costs). An example of the use of materials cost as the base for a secondary materials-related overhead rate is given under Separate Rates for Production Factors in this section.

Advantages and Disadvantages of Materials Overhead Rates. The direct materials cost method is easy and simple to use. It gives reasonably accurate results where grades and prices of raw materials do not differ widely, where quantity and cost of materials in each product is uniform, and where processing

is uniform. It has usefulness in special departments of some large organizations, in very simple types of small business, and in the application of materials burden by the use of a secondary overhead rate. The disadvantages are:

1. There is no logical relationship between manufacturing cost and the cost of raw materials used.
2. As in the direct labor cost method, the time factor is lacking.
3. Where prices of items of raw materials differ widely, the products made from the items of high price are weighted with more than their share of overhead.
4. This method is inequitable where part of the materials passes through all processes, and part through only some processes.

PRIME COST FORMULA. Overhead may be applied to the product by using prime cost (direct labor and direct materials) as a base. The mechanics are similar to those of the direct labor cost and materials cost methods. The computation is as follows:

$$\frac{\text{Anticipated overhead costs}}{\text{Anticipated direct materials} + \text{anticipated direct labor dollars}} = \text{percentage of prime cost}$$

As in other methods, the factors of the expression may be in terms of expected actual, normal, or practical capacity; also, they may be blanket or departmental in nature. Thus, if overhead cost for a certain mixing department is expected to be \$360,000, while direct materials and direct labor costs are expected to be \$230,-000 and \$170,000, respectively, the rate for the application of overhead is:

$$\frac{\$360{,}000}{\$230{,}000 + \$170{,}000} = 90 \text{ percent of prime cost}$$

That is, for every dollar of prime cost, add \$0.90 for overhead. The overhead cost applicable to each process for the month is determined by applying this rate.

PROCESS A-11

Mixing Department	
Direct materials cost	\$1,030
Direct labor cost	770
Prime cost	\$1,800
Overhead cost at 90 percent	1,620
Total cost	\$3,420

Advantages and Disadvantages of Prime Cost Method. The prime cost method is simple and easy to use, since all data are immediately available without additional compilation. Its use is restricted, however, to those cases where there are no wide variations in processing. It is likely to prove more useful for certain departments rather than for the plant as a whole. The objections to the method are:

1. It allows raw materials cost to occupy too prominent a position in the computation of applied overhead costs. Overhead costs are more closely related to labor costs than to materials cost, and yet each dollar of labor cost and each dollar of materials cost are given the same weight.
2. It does not make use of the time factor in applying overhead.

MARKET VALUE OR SALES PRICE BASE. The formula for this method is:

$$\frac{\text{Anticipated overhead cost}}{\text{Anticipated market value of units to be produced (or sold)}} = \text{overhead rate as a percentage of sales price}$$

This method has not been widely used. In three special situations, however, it has seen some acceptance:

1. In applying some, if not all, of the distribution and other nonmanufacturing expenses among the various classes of product sold.
2. In applying research, engineering, and development costs when there is no direct relationship among these costs and the individual product lines.
3. In the case of joint products, when the production process simultaneously yields two or more products. In this situation the formula frequently is re-arranged to show:

$$\frac{\text{Market value, Product } A}{\text{Total market value, all joint products}} = \text{percent of overhead applied to Product } A$$

Although the method is quite simple, it provides a very arbitrary application of costs. Exceptions to the rule may exist for salesmen's commissions, fire insurance on inventories, and a few other isolated examples, but ordinarily there is no logical relationship between the overhead costs incurred and the market value of the product The method tends to apply cost according to the ability of the product to shoulder the charge, rather than according to the benefits which the products received. The method consequently is open to criticism on theoretical grounds.

MOVING AVERAGE BASE. All the methods previously described have been based on anticipated or expected rather than actual costs. For reasons given under Predetermined vs. Historical Overhead Rates in this section, anticipated costs are to be preferred. Neuner (Cost Accounting), however, describes a method based on **actual costs,** which overcomes some of the deficiencies previously noted:

> This method uses actual figures for the past twelve months in ascertaining overhead rates. No estimated or predetermined overhead figures are necessary. Actual manufacturing overhead costs for the past twelve months are totaled and averaged (by dividing by twelve). The resulting average represents the amount of manufacturing overhead applicable to production for the following month. The overhead rate may be based upon the materials cost, labor cost, labor hour, machine hour, or production unit

The overhead rate is computed by dividing the average overhead for the past twelve months by the estimated direct labor hours (direct labor dollars, machine hours, etc.) for next month. A new rate is computed each month by extending the moving average one month ahead.

DEPARTMENTAL OVERHEAD RATES. In order to permit a more accurate application of overhead costs to the different products being produced, a large number of firms compute separate overhead rates for the different production departments within the plant. Then, when overhead is applied to a particular job, it is applied separately for the time spent in each department. This makes it possible to charge each job for the particular type of work required rather than on the basis of a **blanket,** or **plant-wide,** rate. Many other firms accomplish the same results by using separate **cost center rates,** or by subdividing the overhead rate in other ways as discussed under Use of Multiple Overhead Rates in this section.

Departmental overhead rates can be based upon direct labor dollars, direct labor hours, machine hours, or upon any of the other bases discussed in this section. Also, one department may use one base, and the other departments may use other bases. Departmental rates can be calculated on the basis of expected

actual costs and activity, or upon the basis of costs and activity under normal business conditions, or under conditions of practical capacity. Examples of the calculation and use of ordinary departmental rates are given for the direct labor dollar base (Fig. 6) and for the direct labor hour base (Fig. 8).

DEPARTMENTAL TOTAL CONVERSION COST RATES. A special use of departmental rates is sometimes found when it is desirable to combine the direct labor cost in a department with the overhead of the department, obtaining the total conversion cost of the operation. Total labor and overhead divided by the number of hours the department is expected to operate yields a **departmental hourly cost rate** in effect, an over-all rental charge for the use of all facilities in the department. This is the case in the printing industry, where the **sold-hour rate** may be used. This rate is a composite of labor and overhead in each department. Expressed as a formula:

L = estimated direct labor cost.
O = estimated overhead.
H = estimated hours the department is expected to operate.

$$\frac{L + O}{H} = \text{hourly departmental cost rate}$$

The outstanding characteristics of the system are:

1. The standard unit of production in all departments is the productive hour.
2. The standard hour cost covers the direct labor plus all overhead cost and departmental and office or general commercial costs—the gross cost exclusive of stock handling and selling.
3. The natural divisions of the processes of manufacture form cost centers or departments for the purpose of determining costs.

COST CENTER OVERHEAD RATES. In the attempt to obtain a more accurate application of overhead costs to the products and the services produced, many firms break down the factory into several cost centers and then compute a separate cost center overhead rate for each center. The method works in much the same way as departmental rates, except that there is usually a finer subdivision.

Cost Center Defined. Cost centers (also designated as **burden centers,** or productive, service, and nominal centers) are units, functions, or areas within an establishment that are homogeneous from the cost point of view; i.e., each center relates to a single type of operation, function, or activity clearly distinguishable from all others. As with departments, cost centers may be classified as productive, service, and nominal. Productive cost centers are sometimes referred to as **direct** cost centers, and service cost centers and nominal cost centers sometimes are referred to as **indirect** cost centers.

Productive cost centers are locations where a particular type of work is done on the product manufactured for sale. A productive cost center may be a single machine; or it may be a group or battery of machines, all alike as to cost, speed, and other operating conditions. A productive cost center may be composed of a single operator engaged in hand assembly work; or it may be made up of a group of men, if they are engaged in the same work. A productive cost center may be a single operation; or it may be several operations, if they are reasonably alike in their cost characteristics.

Service cost centers are individual activities, like machine repairs, building repairs, or tool design, which support the productive activities. The cost of each

of these cost centers must be allocated to productive cost centers and other service centers (in some cases by the use of individual service center rates).

A nominal cost center is similar to a service cost center except that there is no particular organization or activity involved. Examples are building-use expenses and payroll taxes. A nominal cost center is simply a convenient grouping of expenses which are related to a common purpose and which are allocable to other cost centers.

Cost Centers vs. Departments. Cost centers are natural divisions of an organization for purposes of measuring the cost of a particular operation and for purposes of applying this cost to product. Departments are natural divisions of an organization for administrative purposes; they fix responsibility for managerial action, for property custodianship, and for operating costs; they conform to the firm's organization chart and define the proper channels of authority. Although departmentalization of overhead costs may be excellent for purposes of controlling overhead costs, it is often not successful for purposes of applying overhead costs to products. Cost center subdivisions are ideal for costing products but may be too miniscule to be useful administratively.

Cost Center Overhead Rate Formula. The formula for the computation of a cost center rate is:

O_d = anticipated direct overhead for cost center.
O_a = anticipated apportioned overhead for cost center.
A = productive activity in units, hours, or dollars.

$$R = \frac{O_d + O_a}{A} = \text{cost center rate}$$

As with rates discussed earlier in this section, the overhead cost and activity used in the equation may be in terms of expected actual, normal, or practical capacity.

Illustrative Cost Centers. A typical list of cost centers for the sausage department of a meat packing plant is suggested in the Encyclopedia of Accounting Systems (Williams and Doris, eds.) as follows: (1) grinding and mixing, (2) stuffing, (3) smoking, (4) cooking, (5) skinning, (6) slicing, and (7) packaging. An example of the calculation and use of cost center rates is given in this section under Cost Center Machine Hour Rates.

COST CENTER TOTAL CONVERSION COST RATES. As in the case of the departmental total conversion cost rate, it is sometimes advantageous to combine direct labor and overhead costs in a cost center to obtain the total cost of operation, exclusive of direct materials. This total, divided by the expected number of hours of operation, yields a cost center hourly cost rate, an over-all rental charge for the use of all facilities in the center. The formula is as follows:

L = estimated direct labor in cost center.
O = estimated overhead in cost center.
H = estimated hours of operation.

$$\frac{L + O}{H} = \text{cost center rate per hour}$$

These rates possess the same advantages that departmental hourly cost rates do. In addition, they are more accurate where diverse operations and equipment are contained within a single department.

In a case study of a Detroit manufacturer, Peden (NAA Bulletin, vol. 20) describes a cost system which **combines cost center and departmental rates,** some being straight overhead rates, others being inclusive cost rates, combining labor and overhead. The company performs two main types of service, coloring of metal parts such as automobile hardware; and the manufacture and assembly of plastic molded parts such as buttons, levers, and knobs used for automobiles, radios, furniture, and building construction. It was decided that the following direct manufacturing departments should be used as cost centers:

Department or Cost Center	Overhead Bases for Costing Product
Polishing	Percentage of direct labor cost
Mixing	Standard rate per pound mixed
Dipping	Percentage of direct labor cost
Granodizing	Standard cost per hundred pieces
Spraying	Percentage of direct labor cost
Finishing	Percentage of direct labor cost
Plastic Molding	Standard machine hour rate

In the polishing, dipping, spraying, and finishing departments, where the labor was more important than the equipment as a cost factor, it was decided to charge such labor directly to the detailed cost sheets and to absorb the burden by means of rates based on the **direct labor cost.** In the mixing department a serially numbered form known as a "batch card" was adopted as a summary of the ingredients of each mix and as a record of the total pounds mixed daily and monthly. It was obvious, therefore, that in this department, it would be accurate and economical to consider all the labor as part of the operating burden and to absorb it into the costs by means of a **flat or standard rate per pound** resulting from the relationship between the total mixing burden and the total pounds mixed. Similarly, in the granodizing room, all operating labor was included in the burden accounts and a cost **rate per hundred pieces** processed was devised. In the plastic molding department, where the machines were of a uniform size and type and wage rates were uniform among the machines, the operating labor costs were included with the burden and absorbed by means of a single **machine hour**

Estimated Annual Costs for Operating Plastic Molding Department

Labor		
Foreman	$ 100	
Operating labor	3,689	
Salvage plastic material	180	
Total, all labor		$ 3,969
Repairs		900
Supplies		3,000
Fixed charges		2,411
Apportioned charges		
General factory		2,520
Total cost		$12,800
Estimated hours		3,200
Hourly cost rate, plastic molding		$4.00

Fig. 13. Computation of hourly cost rate.

rate, the variances in cost being reflected as factors of the time required for production.

Thus, the rate for plastic molding is, in effect, a cost center hourly cost rate. Some of the other rates are departmental rates on the basis of direct labor dollars. The plastic molding rate is derived as shown in Fig. 13.

This **inclusive hourly rate** is used in determining the product cost on various cost records.

COST CENTER RATES AS SUPPLEMENTS. Apparently only a small percentage of companies use both departmental and cost center overhead rates. Under this arrangement only the overhead costs directly assignable to individual cost centers are applied to jobs, lots, processes, etc., by the use of cost center rates Overhead items which are **indirect costs** of the various cost centers are not included in the cost center rates but are applied to the product by the use of departmental rates or plant-wide rates. Schlatter and Schlatter (Cost Accounting) recommend this method. The decision as to what is to be handled as direct cost must be made arbitrarily. Depreciation on building, for example, can be handled either as direct or indirect cost.

It is not uncommon to find a **combination of plant-wide and cost center rates** such as the following:

1. A special plant-wide rate, based on materials cost or weight, for applying materials-related costs to product.
2. Separate cost center rates for applying all other overhead costs to product.

Since it is possible for the cost center rates to be applied on a different base from that used for the departmental rates, the rate structure can be made quite sensitive to the different factors creating overhead costs. Thus, with careful planning, the cost accountant can achieve a highly selective and accurate overhead rate structure. For example, an **overhead rate structure** could be drawn up along the following lines:

1. A plant-wide rate, based on material cost, for applying materials-related overhead.
2. Departmental rates, based on direct labor hours (or dollars) for applying costs of supervision and other payroll-related costs assignable to the department of which the particular cost center is a part.
3. Separate cost center rates, based on machine hours (or direct labor hours) to apply the direct overhead costs belonging to particular productive cost centers.

The main disadvantage of such a rate structure is its complexity. Considerably more time and expense is required to compute the rates and to use them in applying overhead to individual jobs, etc.

RATES BY CLASS OF PRODUCT. It appears that very few companies use separate overhead rates for each class of product. There is, however, the unusual case of a company using seven rates, one for each group of sales lines as though made in a separate factory, although actually one department may partially process four or five of the seven lines.

In computing rates by class of product, the anticipated overhead costs of the plant or department are first allocated among the various product classes based upon factors associated with the plans for manufacture Then the anticipated overhead for each line of product is divided by the anticipated production activity for the period, using any of the previously mentioned bases for applying

overhead costs (direct labor dollars or hours, machine hours, units, etc.). The overhead rate formula is:

$$\frac{\text{Anticipated overhead belonging to the product class}}{\text{Anticipated output for the product class (direct labor dollars, hours, units, etc.)}} = \text{overhead rate for the product class}$$

As with other overhead rates, the factors of the equation may be in terms of actual expectation for the year, or normal or practical capacity. The rate also may be plant-wide, or for an individual department, cost center, or other segment of factory operations such as materials handling, research, or inspection.

Where **research and development costs** do not benefit all product lines in the same way, separate product rates may well be used for applying this part of manufacturing overhead.

SEPARATE RATES FOR PRODUCTION FACTORS. March (NAA Bulletin, vol. 33) makes some strong arguments for the separation of the overhead rate into segments related to the **factors of production**:

> The principal production factors are materials, men, and machines. A fourth—outside processing—must also be considered in some cases. If the utmost accuracy is wanted where different products require different proportions of the services of these four factors, the indirect costs to maintain the flow of production-factor services should be assigned, first, to the production factors benefited, and then to products in proportion to the production-factor services utilized.
>
> Although absolute accuracy cannot be attained in any method of costing burden, separate application of each of the four types of burden is a principle which must be accepted as theoretically sound.

March illustrates his point as follows:

> Whether to apply each of the production-factor burden types separately or to merge two or more of them is a matter of judgment, depending on the circumstances in each case. The more varied the products and the processing, the more reason there is likely to be for separate application. If the materials and the processing are similar in the various products of a plant, a simpler procedure can usually be developed which will give satisfactory results. It may be desirable to make tests to determine whether separate application is necessary. This will be done for a hypothetical situation in a number of illustrations based on data given [in Fig. 14]. The illustration shown as Case 1 represents the full use of the production factor basis, as follows.

Case 1: Burden applied.	Product A			Product B		
Material burden, at 10%	$100	$100		$200	$650	
Outside-processing burden, at 15%	-0-			450		
Process-personnel burden						
Department 10, at $0.40 per direct man hour	48	148	$292	-0-	100	$150
Department 20, at $0.50 per direct man hour	100			100		
Work-point burden						
Cost Center 11, at $1.00 per machine hour.	40	144		-0-	50	
Cost Center 21, at $0.25 per machine hour.	20			50		
Cost Center 22, at $0.35 per machine hour.	84			-0-		
Total burden cost	$392			$800		

It has been stated that this is not always necessary. However, in the assumed set of circumstances, it is evident that the product cost data would be unreliable if procurement burden and process burden were merged for the purpose of burden application. In Cases 2 and 3, where that is done on over-all and departmental man hours, respectively, the burden cost of Product B is grossly understated.

Case 2: Application at over-all or blanket rate based on direct man hours.

	Product A	Product B
Burden applied, at $1.13 per direct man hour ...... ($129,000 ÷ 114,000 hours)	$361.60 (for 320 hr.)	$226.00 (for 200 hr.)

Case 3: Application at departmental rates based on direct man hours procurement burden ($16,000 + $15,000 = $31,000) allocated to departments on basis of direct man hours (60,000 in 10, 54,000 in 20) in order to get departmental rates.

	Product A	Product B
Department 10, at $1.01 ($60,316 ÷ 60,000 hours)	$121.20	–0–
Department 20, at $1.27 ($68,684 ÷ 54,000 hours)	254.00	$254.00
Total burden applied	$375.20	$254.00

Where the procurement burden is to be separated from process burden, it may be feasible to merge the two types of procurement burden, i.e., material burden and out-

1. Monthly burden and monthly volume

	Predetermined Monthly Burden	Predetermined Monthly Volume of Base Factor	Burden Rates for Separate Application
Material burden	$ 16,000	$160,000 materials cost	10% of materials cost
Outside-processing burden	15,000	100,000 outside processing cost	15% of outside-processing cost
Process-personnel burden			
Department 10	24,000	60,000 direct man hours	$0.40 per direct man hour
Department 20	27,000	54,000 direct man hours	$0.50 per direct man hour
Work-point burden			
Department 10			
Cost Center 11.....	20,000	20,000 machine hours	$1.00 per machine hour
Department 20			
Cost Center 21.....	6,000	24,000 machine hours	$0.25 per machine hour
Cost Center 22.....	21,000	60,000 machine hours	$0.35 per machine hour
	$129,000		

2. Base-factor tally for two key products

	Product A	Product B
Materials cost	$1,000	$2,000
Outside-processing cost	–0–	3,000
Direct man hours		
Department 10	120	–0–
Department 20	200	200
Machine hours		
Cost Center 11	40	–0–
Cost Center 21	80	200
Cost Center 22	240	–0–

Fig. 14. Assumed data for cases showing production factor burden application.

side-processing burden. That is done in Case 4, which deals with procurement burden only. In this example, $120 of procurement burden is applied to Product A as compared with $100 in Case 1. The deviation is 20 percent. For Product B the deviation is $50, or 8 percent. In our hypothetical case, this procedure would understate the costs of products which require outside processing and would overstate the costs of the other products. The figures for comparison with Case 1 are given in Case 4.

Case 4: Procurement burden applied on the basis of materials and outside-processing cost.

	Product A	Product B
Procurement burden, at 12 percent ($31,000 ÷ 260.000) of the cost of materials and outside processing	$120.00	$600.00

March also shows cases for departmental rates but concludes that because of the wide variation between products and between cost centers in the type of work involved, only the cost center rates are accurate.

Materials Overhead Rates. Many examples can be found in industry of the use of a separate rate for applying materials-related overhead costs. These rates are called by various titles, such as materials overhead rate, materials burden rate, loading charges, and materials handling charges or rates.

Labor and Facility Overhead Rates. Separate rates for applying the labor-related and facility-related costs of a department or cost center appear to be unpopular in industry. Although they do provide more accuracy in the allocation of costs, the increased accuracy in most situations is not significant. Furthermore, the calculation and use of these rates does involve considerable complexity.

OVERHEAD RATES FOR SERVICE DEPARTMENTS. Ordinarily when departmental or cost center overhead rates are used, they are computed only for the **producing departments**, i.e., the departments which work directly upon the product which is manufactured for sale. Under the usual arrangement, service department costs are allocated to producing departments and are included in the overhead rates of each producing department. Under special circumstances, however, overhead rates may be computed for **service departments** and can be used either to apply these costs to products directly or to distribute these costs to other departments where they will be applied indirectly to products. This section is concerned only with the first employment of service department overhead rates; the second use is discussed in the section on Distribution of Manufacturing Overhead.

Separate service department overhead rates sometimes are found in the following situations:

1. When the base used in the producing department overhead rate is not appropriate for the application of the cost of the function performed by the service department.
2. When the service department sometimes serves as a producing department.

Service Department Rate Applications. The most common example of this is the use of a separate rate to apply the costs of the materials handling department. The problem is this: The overhead rates of the producing departments apply overhead costs in proportion to the labor or machinery utilized, while the costs of purchasing, shipping, receiving, storing, and handling materials should be applied to the final product in proportion to the materials used. Therefore a separate **materials overhead rate** is computed and used.

Some of the other situations for which separate service department rates are employed include the following:

1. Payroll department (when machine hour rates are used in the producing departments).
2. Tooling, tool setup department.
3. Packing and crating department.
4. Inspection department.
5. Research and development department.

Some plants may consider these departments as producing departments when they compute separate overhead rates for them.

Work on Product by Service Department. In some cases a service department may also serve as a producing department, in which case the materials, labor, and overhead costs usually should be charged to the product. In a small firm, for example, one department may design and construct tools or dies for use by other departments (a service department function) and also manufacture certain parts for use on the final product (a producing department function). Similar examples include:

1. Boiler room (when steam is also sold).
2. Repair and maintenance (when service is also sold, or where department also manufactures or repairs products for sale).

In each of these situations, proper costing requires that a predetermined overhead rate be computed for the service department. For example, assume that the total costs of the tool room are expected to be as follows:

Direct materials used in producing tools and parts	$100,000
Direct labor used in producing tools and parts	200,000
Other overhead costs (supplies, electricity, taxes, depr., etc.)	400,000
Total tool room costs budgeted for the year	$700,000
Total machine hours budgeted for the year	32,000
Total direct labor hours budgeted for the year	24,000

Assume further that three-fourths of the time of this department is scheduled for the manufacture, repair, and maintenance of tools, while one-fourth is scheduled for the manufacture of parts to be included in the final product.

Direct materials and direct tooling labor should be charged directly to the department served (in the case of tooling costs), or to the job, lot, or product manufactured (in the case of parts manufacture). This leaves only the $400,000 of overhead to be considered in the overhead rate. The $400,000 overhead cost may be allocated between tooling and parts manufacture, considering differences in the type of work involved, or if the type of work is not greatly different, a single overhead rate may be computed for both tooling and parts manufacture as follows:

$$\frac{\text{Anticipated overhead cost}}{\begin{array}{c}\text{Anticipated Activity (Direct labor}\\ \text{dollars, hours, machine hours, etc.)}\end{array}} = \text{overhead rate}$$

Assuming that the rate is to be based on direct labor hours, it would be

$$\frac{\$400{,}000}{24{,}000 \text{ hours}} = \$16.67 \text{ per direct labor hour}$$

This rate would be used in the normal manner for applying overhead costs to the **salable products** worked on in this department. The rate could also be used in costing **tooling services** to other producing departments.

SEPARATE FIXED AND VARIABLE OVERHEAD RATES. Neuner (Cost Accounting) observes:

There is an increasing tendency to use separate predetermined overhead rates for the fixed overhead and for the variable overhead, as well as for general administrative overhead. The purpose of this breakdown is a more effective analysis and control of variations when they have been functionally grouped.

As Neuner points out, the primary reason for using separate rates for fixed and variable overhead is not more accurate application of costs to product but rather an effort to secure more accurate distribution of miscellaneous and service department overhead to the departments benefited thereby. Since overhead distribution is detailed in the section on Distribution of Manufacturing Overhead, only a summary treatment is given here. When predetermined rates are used for distributing overhead to producing departments, fixed costs will be overdistributed or underdistributed unless they are separated from the predetermined rate and distributed separately.

A few firms have pointed out other reasons for using one rate for applying fixed and another for applying variable overhead to product:

1. Dual rates such as these can be used as an alternative to direct costing and, as such, are useful in making clear the contribution of each product toward the recovery of fixed overhead and profit. At the same time, the **full factory cost** of the product is retained.
2. Dual rates such as these can be so used that fixed costs are applied on one base and variable costs are applied on another base. Fixed costs, for example, may be applied on the basis of number of units (weight or volume), assuming that this base accurately reflects the proportion of available facilities utilized by each product line. Variable costs may be applied on the basis of direct labor hours, since they are closely related to the volume of productive activity actually carried on. The advantage claimed for using a rate structure of this type is more accurate costing in that it tends to apply fixed costs to product in a manner closely reflecting the causes of these costs. The disadvantage of the method clearly is its complexity and the clerical time required.
3. Dual rates such as these can be used in such a way as to avoid **volume variances** (i.e., underabsorbed or overabsorbed fixed cost). Under this approach fixed costs are applied to the different products each month, based on available capacity, or in such a way as to apply exactly the same dollar amount of fixed expense as will be incurred. This method contradicts one of the main arguments for using predetermined overhead rates because it results in a fluctuating unit cost as fixed costs are spread more heavily or lightly in response to a changing volume of output.

SUPPLEMENTARY RATES FOR APPLYING UNDER- OR OVER-APPLIED OVERHEAD. A supplementary overhead rate may be computed at the end of each month and used to adjust the costs already computed for jobs, lots, processes, etc., worked on during the month.

Where **predetermined rates** are used, a difference always exists between the actual amount of overhead cost for the period and the amount of absorbed overhead cost. This under- or overabsorbed overhead, divided by the number of hours, dollars, or units, gives a supplementary rate, thus

$$\frac{\text{Actual overhead—absorbed overhead}}{\text{Hours, dollars, or units}} = \text{supplementary rate}$$

Assuming a machine rate per hour for a turret lathe of $2.20, actual hours of operation for the month of 1,450, actual overhead cost on the turret lathe of $3,560, and

machine time for part X-127 of 0.75 hours, under this situation, the amount of overhead costed to jobs during the month amounts to:

1,450 hours × $2.20 per hour = $3,190 of absorbed overhead

Since the actual overhead charged against this turret lathe totals $3,560, there is underabsorbed overhead for the period of $370. A supplementary rate is then computed and used to create additional charges to the product, to absorb the actual costs. This rate, computed at the end of the month, is $0.255 per machine hour, obtained by dividing $370 by 1,450 hours. That is, for each machine hour there is to be added $0.255 additional to adjust the overhead applied to actual.

The overhead cost of part X-127 now becomes

Overhead cost on machine hour basis (0.75 × $2.20)	$1.65
Supplementary cost for overhead, to adjust to actual ($0.255 per hour × 0.75)	.19
Overhead cost, actual	$1.84

If the overhead absorbed during the month by the use of the estimated rates is in excess of actual overhead, the adjustment is in the form of a deduction from the previously applied overhead. An alternative method for computing the supplementary rate expresses the underapplied overhead as a percentage of the overhead already applied. Using the same illustration, the results are as follows:

1. Underapplied expense ($3,560 − $3,190)	$ 370
2. Applied expense	$3,190
3. Supplementary rate (line 1 ÷ line 2)	11.6%

Adjusted Cost of Part X-127

Applied cost	$1.65
Add supplementary cost (11.6% of $1.65)	.19
Actual overhead cost	$1.84

Supplementary rates are not limited to those cases where machine hour rates have been used; they may be computed in connection with any method.

Advantages and Disadvantages of Supplementary Rates. There is no need for supplementary rates under most circumstances. Their only advantage lies in the fact that they make possible the costing of total actual overhead to the product produced. If estimated actual rates have been used, and they prove to be greatly in error, it is necessary to adjust the cost sheets to obtain relatively accurate information. This is the case on government contracts run on a cost-plus basis (cost being defined as actual cost for the period of the specific contract). Where normal or practical capacity rates are in effect, the use of supplementary rates gives additional cost information for purposes of comparison.

On the other hand, final disposition of the cost sheets is delayed until after the close of each month; also, the use of supplementary rates greatly increases the detailed cost work, since job cost cards must be recomputed. In a seasonal business where estimated rates have been determined for a year in advance in order to smooth out irregularities of costing due to the nature of the industry, it is inequitable to apply total actual overhead for any one month to the total product for that month. Rather, the underabsorbed overhead in one month tends to be offset by overabsorbed overhead in another month. As Schlatter and Schlatter (Cost Accounting) point out, the supplementary rate produces false unit-cost figures because it is based on the fallacious assumption that all the manufacturing burden of a month should be charged to the goods produced during that month, regardless of the volume of activity. When the net amount of variance between actual and absorbed overhead is determined at the close of the

year, it is too late to recompute all the cost sheets by the use of supplementary rates. Finally, where **normal rates** are used, the application of supplementary rates defeats the basic concept behind the use of normal or practical capacity rates.

No data are available regarding the extent to which industry is using supplementary rates. They are used, however, in some instances to spread premium for overtime work over all production. On occasion, these rates are called **super-burden rates,** and as many as three of them have been in use in one company at the same time. Again, some companies price inventory at standard, but use supplementary rates for price setting, government contract costing, etc.

CHANGING OVERHEAD RATES. Usual practice involves the setting of overhead rates on an annual basis and their use without adjustment for at least a year. This practice serves to level out costing through seasonal swings of activity and to tie rate determination in with the usual **budget period.** Loss of costing continuity and the attending loss of comparative cost data justify reluctance to change rates more frequently than at annual intervals. Changes in patterns of production, prices, efficiencies, production capacity, and sales expectancy usually make overhead rates inaccurate after a period of a year or longer and thus cause the need for complete review and possible revision. If this review and revision is accomplished at regular annual intervals, the discontinuity of cost data is most easily interpreted. The policy of an individual company with regard to revision of overhead rates should depend upon the rapidity of change of the basic factors which are reflected in overhead rates and upon management's need and desire for current costs of products and significant overhead variance information.

Frequency of Revision. Practice regarding the frequency of revision of overhead rates is indicated in the tabulation from a special NAA research study (NAA Bulletin, vol. 19):

FREQUENCY OF OVERHEAD RATE REVISION

Frequency	Number of Companies
Monthly	7
Quarterly	8
Two to four times a year	3
Semi-annually	22
Annually	101
Every two or three years	6
When necessary	37
Infrequent or rare revisions	19
Use actual rates	18
No answer	3
Total companies	221

Thirty-seven companies reported that overhead rates were revised only when necessary. The following comments indicate what changes these companies consider important enough to warrant a change in burden rates:

"Every time a major change takes place."

"When necessary due to changes in basic conditions; average once every two years."

"Whenever there is a drastic fluctuation in prices and wage levels."

"Whenever material or labor rates change or there is a change in plant hours."

"When factory layout changes or new facilities are added."

"When made necessary by some such change as a shift in costs from direct to indirect through greater mechanization of operations, etc."

"They are calculated to cover a business cycle and are adjusted only when violent production swings change the picture radically."

On the other hand, some companies reported infrequent use of change of rates, having used the same rate for periods up to 15 years. The reason generally assigned is the fear that the basis of comparison would be destroyed by more frequent **rate changes.** However, over 80 percent of the companies studied have a regular plan for reviewing their overhead rates

It is difficult to generalize significantly from this small sampling, especially in view of the many qualifications written in by respondents on the questionnaire form on which the above results are based. It is noted that of the 201 companies which reported using **predetermined rates,** 141 were making a revision annually or more frequently. From scattered comments published since this survey was made, it appears that a large number of firms follow this practice. This view is supported by a more recent research study (Research Series No. 13) made by the Committee on Research of the National Association of Accountants (NAA Bulletin, vol. 29) of 63 companies using standard cost systems. The practices of the companies surveyed are reported as follows:

Frequency of Overhead Rate Revision	Number of Companies
Annually	43
Semiannually	3
Quarterly	3
When considered necessary	14
Total	63

Miscalculated Overhead Rates. Errors in the calculation of the overhead rate may arise because of misjudgment regarding the numerator (anticipated overhead cost) or the denominator (anticipated activity) of the fraction. A large **under-absorbed or overabsorbed overhead balance** does not by itself indicate that the overhead rate has been miscalculated. When normal or practical capacity overhead rates are used, the rate is purposely designed to yield an underabsorbed or overabsorbed overhead balance reflecting the extent to which available capacity is utilized (see section on Manufacturing Overhead and Normal Activity). Furthermore, when the overhead rate is based on expected actual conditions, **seasonal variations** in costs and activity may lead to a large accumulation of underabsorbed or overabsorbed overhead which will tend to be liquidated during the remainder of the year.

The most reliable way of detecting an error in the overhead rate is to re-examine the factors used in the numerator and denominator of the fraction, bearing in mind all the particulars regarding the type of overhead rate being used. Small errors are to be expected, since the rate is an estimate, and such small errors should be ignored (i.e., the cost of the product remains unadjusted, although profits are corrected by the treatment given to overabsorbed or underabsorbed overhead discussed in the section on Manufacturing Overhead and Normal Activity).

Methods of Correction. If a substantial over- or underabsorption of manufacturing overhead builds up during the year, due to differences between the budgeted and actual figures for production or for costs, it may be desired to change the overhead rate during the year to compensate for the previously accumulated variance. Neuner (Cost Accounting) describes two alternative procedures.

The easier of the two involves the preparation of an estimated production and overhead schedule for the remaining months of the year and the calculation of a new overhead rate and its use during these remaining months. This method involves much less work than the second alternative, but it gives incorrect unit costs for the whole year. For example, if the rate had been too high, the goods manufactured during the early months would carry too high an overhead cost. Conversely the goods manufactured during the remaining months would carry too low an overhead cost because of the overcharging during the early part of the year.

The more correct method is to go back to the beginning of the year, recalculate the rate for the whole year, make a correcting journal entry for the work done to date, and correct the entries made on each of the job cost sheets. The second method obviously involves more clerical work than the first.

If the rate is not changed during the year, there presumably will be a problem of disposing of the balance in the manufacturing overhead account. This is discussed in the section on Manufacturing Overhead and Normal Activity.

Direct Costing

DIRECT COSTING DEFINED. A definition frequently quoted for direct costing is the one given by Neikirk (NAA Bulletin, vol. 32):

> Direct costing should be defined as a segregation of manufacturing costs between those which are fixed and those which vary directly with volume. Only the prime costs plus variable factory costs are used to value inventory and cost of sales. The remaining factory expenses are charged off currently to profit and loss. However, the point to be emphasized is that direct costing is primarily a segregation of expenses and only secondarily a method of inventory valuation. By this approach, full attention can be directed to the effect which direct costing has on the profit and loss statement and supplementary operating reports.

A more elaborate definition of direct costing should emphasize four features which characterize this method:

1. **Method of recording and reporting.** Direct costing is a method of recording as well as reporting costs. Unlike differential cost analysis and break-even point analysis, which utilize traditional records, direct costing requires a unique method of recording cost transactions as they originally take place.
2. **Separation of costs into fixed and variable elements.** Under direct costing, all types of operating costs (factory, selling, and administrative) are separated into fixed and variable components and are recorded separately.
3. **Variable costs applied to product.** Variable cost elements are handled as product costs, i.e., they are charged to the product at the appropriate moments and follow the product through the inventory accounts, and thus become treated as expenses when the product is sold. Variable distribution costs normally are chargeable to product at or near the moment of sale, and thus do not become included in inventory values.
4. **Fixed cost written off as period costs.** Fixed costs (including fixed factory overhead) are handled as period costs; i.e., they are written off as expenses in the period in which they are incurred. They do not follow the inventories through the accounts but rather are treated in the way which is traditional for selling and general administrative expenses.

PURPOSES OF DIRECT COSTING. The main argument of the proponents of direct costing is that this method enables management to utilize cost information more effectively. In its Research Series No. 23 (NAA Bulletin,

vol. 34) the National Association of Accountants states: "Direct costing is a plan for providing management with more information about cost-volume-profit relationships and for presenting this information in a form more readily understandable by management at all levels."

Sometimes direct costing is described as a method which eliminates fixed costs from inventories and which removes "paper" profits or losses arising from the capitalization of fixed period costs. These features are the ones most widely criticized by other accountants. They are not primary objectives of the direct costing method, although they are natural by-products of the recording procedure. In order to overcome these objections to direct costing, Marple (Accounting Review, vol. 30) and others advocate the use of adjustments made at the end of the year on the summary reports so as to restate the results in the traditional manner. When this is done, interim reports for internal managerial uses will still be prepared along direct costing lines.

Cost-Volume-Profit Information. Direct costing attempts to improve the procedure for collecting and presenting information regarding the relationship between cost, volume, sales prices, product mix, and profits. This type of information is not necessary for the determination of net income or for the measurement of product costs, but it is important to management in **budgeting** and **profit planning,** in **selecting product lines,** and in deciding upon the relative emphasis to be given to each line, in appraising the **performance** of sales personnel, in establishing **pricing policy,** and as a basis for decision in many other problems involving alternative choice. NAA Research Series No. 23 (NAA Bulletin. vol. 34) reports that "Users of direct costing view the ready availability of cost data in a form appropriate for profit planning as a major benefit from direct costing."

Regarding management's need for direct costing, the same report states that an understanding of the relationships between costs, volume, and profits is vital to management if they are to make plans and formulate decisions with maximum effectiveness. Under traditional costing methods, it has been necessary to supplement the routine cost reports with special studies, often prepared outside the books, in order to furnish information as needed. Some examples of these supplementary reports are **break-even charts, marginal cost and income analysis, P/V studies,** and **differential cost analyses.** While these supplementary studies can be designed to furnish the information needed by management, their use involves extra work, they cannot be efficiently prepared to cover all problem areas, and when used as an adjunct to regular cost data, they often prove to be confusing to management (see section on Cost-Volume-Profit Relationships).

Ease of Understanding by Management. In order to be useful to management, cost accounting information needs to be accurate, timely, and complete. But over and beyond this, management must have faith in the figures and must understand their significance. Schlatter and Schlatter (Cost Accounting) point out that many accountants have been attracted to direct costing because of criticism by their managements regarding the complexity of the presentation under traditional costing methods. More specifically, Matz–Curry–Frank (Cost Accounting), in their discussion of direct costing in relation to unapplied expenses, state:

> Direct costing offers a solution to the potential difficulties of explaining unapplied expenses. The proponents of direct costing believe that the separation of fixed and variable expenses, and the accounting for each according to some direct cost plan,

will simplify both the understanding of the income statement and the assignment of costs to inventories. The possibility of having over- or underapplied manufacturing expense, or of having increased sales yet decreased earnings, is reduced to a minimum because fixed expenses are considered a period and not a product cost. As fixed expenses should remain about the same in total, if sales increase, profits will increase, and vice versa.

DIRECT COSTING TERMINOLOGY. Several terms come into use in a new or a different way when direct costing is used. Some of these terms are used primarily in the recording phase and others in the reporting phase. Descriptions of these terms are given in the subsequent paragraphs.

Fixed, Variable, and Semi-variable Costs. Fixed, variable, and semi-variable costs are described more fully in the section on Accumulation of Manufacturing Overhead. NAA Research Series No. 23 (NAA Bulletin, vol. 34) explains fixed and variable costs as follows:

> Changes in volume do not affect all cost components alike, for some components vary in total directly and proportionately with volume while other components are not changed in total by changes in volume. Costs of the first type are usually spoken of as variable costs, while those of the latter type are called fixed costs.
>
> The terms "standby cost," "constant cost," "time cost," and "capacity cost" are also in current use to designate the same type of cost here called "fixed."

Semi-variable costs are costs which vary in some way other than the fixed or variable costs. At least four types are frequently found:

1. **Fixed and variable elements combined,** such as indirect labor when a minimum organization is necessary to operate, but is easily supplemented as the need arises.
2. **Cost increases by steps,** when increases in volume lead to the addition of a new shift, the hiring of assistant foremen or other salaried supervisor, etc.
3. **Seasonal costs,** when costs tend to be higher during certain months than during others, due to climate (heat and light), custom (machine repair, vacation pay), or other reasons not connected with the volume of output.
4. **Cost increases at an increasing or decreasing rate,** often experienced when a particular department or activity reaches or exceeds its practical capacity.

With direct costing, only fixed and variable cost classifications are recognized. Semi-variable costs must be considered as fixed, or as variable, or as partly fixed and partly variable. Semi-variable costs of the step type, or the seasonal type, usually are recorded as fixed costs. Semi-variable costs which are combinations of fixed and variable elements usually are broken down and recorded separately as fixed or as variable. Semi-variable costs which increase at an increasing or decreasing rate may be classified as fixed or as variable, depending upon the **rate of variability** which exists in the output range in which the firm expects to operate. Some criticism of direct costing has been expressed over these somewhat arbitrary methods which are necessary in the handling of semi-variable costs.

Product Costs and Period Costs. Product costs are those costs which are charged to inventory accounts and which are included in the cost of the product as work in process, finished goods, or cost of sales. When a cost is handled as a product cost, it means that it is treated as an asset until the product is sold or disposed of, at which time it becomes an expense.

Some obvious examples of product costs are **raw materials** and **direct labor.** With conventional cost accounting methods, both fixed and variable factory overhead costs also are treated as product costs. With direct costing only the

variable costs of operations are treated as product costs; this would include the prime costs (raw materials and direct labor) and the variable part of factory overhead costs. **Variable distribution costs** would also be charged to the product but only at the time of sale.

An NAA report, Research Series No. 10 (NAA Bulletin, vol. 28) points out that even with conventional cost accounting methods, certain **inventoriable costs** frequently are not treated as product costs because of the practical inconvenience involved. This was found to be true of packaging costs, storage, research and development, and the factory part of administrative salaries, of taxes, and of other **joint costs.**

Period costs are those costs which are written off as expenses in the period in which they are incurred. Period costs are not treated as a part of the cost of inventory, and consequently their treatment as expense is not delayed until the moment of sale. Period costs may require adjustment for **accruals or deferments,** but these adjustments are strictly on a time allocation basis.

Under conventional costing methods, the period costs are those appearing on the income statement below the gross profit figure. They are the **operating expenses** (selling and general administrative expenses) and the **nonoperating expenses** (other expenses, extraordinary losses, and income taxes).

Under direct costing methods, the period costs are composed of the fixed part of the operating costs (i.e., fixed factory overhead, fixed selling costs, and fixed general administrative costs) and the nonoperating expenses. This requires the income statement to be reorganized somewhat (see Fig. 18D) and results in the use of some new terms: direct (or variable) cost of goods sold, **manufacturing margin,** and **merchandising margin** (marginal income).

Direct or Variable Cost of Goods Sold. This is sometimes called "variable factory cost of goods sold" and is composed of the raw materials, direct labor, and variable factory overhead costs belonging to the products which were sold during the period. It is computed in the same way as the traditional cost of goods sold except that, under direct costing, only the variable part of factory overhead cost is included (see Fig. 18C and 18D).

The direct-cost-of-goods-sold figure includes only those costs which presumably would have been avoided had the firm not produced the product. This is sometimes referred to as the **"out-of-pocket manufacturing cost."** When stated on a per unit basis, this cost is approximately equal to the additional cost involved in manufacturing one additional unit. Most of the advantages of direct costing for managerial decision making derive from these special meanings which attach to the direct-cost-of-goods-sold figure.

Manufacturing Margin. Manufacturing margin, sometimes called **variable gross margin,** is computed as follows (see Fig. 18D): Manufacturing margin equals sales less direct cost of goods sold. This figure indicates how much the sale of the product contributes toward the recovery of variable distribution costs and period costs (which are presumably unavoidable).

Marginal Income. Marginal income, sometimes called "merchandising margin," "profit contribution," or "contribution to fixed costs and profit," is computed as follows (see Fig. 18D): Marginal income equals sales less direct cost of goods sold less variable distribution expenses; or marginal income equals manufacturing margin less variable distribution expenses.

Marginal income is the profit before considering period costs. The marginal income figure indicates how much the sale of the product contributes toward

the recovery of period costs. Since the period costs presumably are uncontrollable (at least in the short run), it can be said that the marginal income indicates the **profit contribution** of the product which was sold.

The term "marginal income" is taken from the economists' vocabulary and is adapted for use with direct costing. In the economists' terminology, marginal income refers to the addition to total profits resulting from the sale of one additional unit of a particular product. Moss and Haseman (Accounting Review, vol. 32) show that marginal income in the economic sense is quite a different and a more highly refined concept than the one used in direct costing.

Direct Costs vs. Direct Costing. Some confusion understandably exists between the use of the term "direct costs" (a cost category) and the term "direct costing" (a method of costing). "Direct costs" are those costs (fixed or variable) directly associated with, and directly chargeable to (rather than allocated or applied to), a particular product, job, process, department, or other segment of over-all operations. In speaking of a small segment of over-all operations such as an individual product, the direct costs tend to be equal to the variable costs, so that the direct costing method properly measures the direct costs in this situation However, in speaking of a larger segment of over-all operations such as a product line, a sales territory, or a division of the factory, the direct costs include many expenses which are nonvariable, and consequently the direct costing method records costs which do not even closely approximate the direct costs. This defect holds true, however, only for the direct costing **recording method.** When costs are reported under the direct costing method, those fixed costs which are directly connected with a particular product line (sales territory, etc.) may be separated from the others and reported in such a way as to reflect the direct costs of a particular segment of over-all operations. This is normal procedure in a well-designed direct costing system (see Fig. 19).

Brummet (Accounting Review, vol. 30) suggests that in order to avoid confusion with direct costs, more appropriate titles for direct costing probably would be **variable costing, differential costing,** or **marginal costing.** This last term is commonly used in Great Britain for direct costing.

DIRECT COSTING VS. ABSORPTION COSTING METHODS. Absorption costing is defined by Kohler (Dictionary for Accountants) as "the assignment of all fixed and variable costs to goods or services produced: an antonym of direct costing." Direct costing and absorption costing are identical with regard to the accounting for raw materials and direct labor and the assignment of these costs to product. Both systems may be designed as job order or process cost systems and may utilize actual or standard costs. Both systems utilize overhead rates, and the variety of different types of overhead rate structures is almost as wide for direct costing as for absorption costing.

The only important differences in methods grow out of the necessity under direct costing of separating costs into fixed and variable components, and the separate treatment given to each of these components. This leads to recognizable differences in accounting methods, as shown in Fig. 15 and detailed in Figs. 16, 17, 18, and 19.

Computation and Presentation of Net Income. Primarily Fig. 18, adapted from Research Series No. 23 (NAA Bulletin, vol. 34), shows the differences between absorption costing and direct costing in: (1) the computation of net income, and (2) the style of presentation for the income statement. Part A gives the basic underlying data used in the illustration. Parts B and C show the com-

	Absorption Costing	Direct Costing
1. Calculation of overhead rates (see Fig. 16)	Rate includes all factory overhead.	Rate includes only the variable factory overhead.
2. Computation of product costs for inventory (see Fig. 17)	Product costs = prime costs + variable factory overhead + fixed factory overhead.	Products costs = prime costs + variable factory overhead.
3. Computation of product costs for judging profitability (see Figs. 18 and 19)	Same as (2) unless supplemented by special studies.	Product cost = prime cost + variable factory overhead + variable distribution costs (unless further refined by special studies).
4. Classification and recording of factory overhead and distribution costs.	Primary classification: department or cost center. Secondary classification: expense item (supplies, indirect labor, etc.).	Primary classification: fixed or variable. Secondary classification: department or cost center. Tertiary classification: expense item (supplies, indirect labor, etc.).
5. Computation of net operating profit and method of presentation (see Figs. 18 and 19)	Gross profit = net sales − cost of goods sold (fixed and variable factory costs intermixed).	Marginal income = net sales − variable cost of goods sold − variable distribution costs.
	Net operating profit = gross profit − distribution costs (fixed and variable expenses intermixed).	Net operating profit = marginal income − fixed factory overhead − fixed distribution costs.

6 Reconciliation of profit figures: net operating profit (direct costing) = net operating profit (absorption costing) ± change in fixed factory overhead costs in beginning and ending inventories of work in process and finished goods.

Fig. 15. Summary of differences between direct costing and absorption costing.

Quarterly Budget for Factory Overhead
(in absorption costing form with fixed and variable costs separated)

	Normal Activity	Expected Activity	Practical Capacity
Direct labor	$ 3,750	$ 4,000	$ 5,000
Percent of practical capacity	75	80	100
Number of units	28,125	30,000	37,500
Variable costs	$ 7,500	$ 8,000	$10,000
Fixed costs	6,000	6,000	6,000
Total Budgeted Overhead	$13,500	$14,000	$16,000

Factory Overhead Rate Computations

A. **Absorption costing**: rates include both fixed and variable costs.

Rate based on expected activity:

$$\frac{\text{Total anticipated overhead for expected activity}}{\text{Expected activity (labor dollars, hours, units, etc.)}} = \frac{\$14{,}000}{\$\ 4{,}000} = 350\% \text{ of direct labor}$$

or $$\frac{\$14{,}000}{30{,}000} = \$.46\tfrac{2}{3} \text{ per unit}$$

Rate based on normal activity:

$$\frac{\text{Total anticipated overhead for normal activity}}{\text{Normal activity (labor dollars, hours, units, etc.)}} = \frac{\$13{,}500}{\$\ 3{,}750} = 360\% \text{ of direct labor}$$

or $$\frac{\$13{,}500}{28{,}125} = \$.48 \text{ per unit}$$

Rate based on practical capacity:

$$\frac{\text{Total anticipated overhead for practical capacity}}{\text{Practical capacity (labor dollars, hours, units, etc.)}} = \frac{\$16{,}000}{\$\ 5{,}000} = 320\% \text{ of direct labor}$$

or $$\frac{\$16{,}000}{37{,}500} = \$.42\tfrac{2}{3} \text{ per unit}$$

B. **Direct costing**: rates include only variable costs

$$\frac{\text{Anticipated variable overhead}}{\text{Activity level assumed}} = \frac{\$7{,}500}{\$3{,}750}, \text{ or } \frac{\$8{,}000}{\$4{,}000}, \text{ or } \frac{\$10{,}000}{\$\ 5{,}000} = 200\% \text{ of direct labor}$$

or $$\frac{\$\ 7{,}500}{28{,}125}, \text{ or } \frac{\$\ 8{,}000}{30{,}000}, \text{ or } \frac{\$10{,}000}{37{,}500} = \$.26\tfrac{2}{3} \text{ per unit}$$

Notes:

1. Instead of a plant-wide rate, several departmental or cost center rates could have been used, in which case, for direct costing, only the variable part of service department costs would be allocated to producing departments and included in their rates.
2. The rates could have been based on direct labor hours, machine hours, etc.
3. With direct costing overhead rates, the distinction between practical capacity, normal activity, and expected activity for the year is no longer significant because the overhead rates are not affected. Also, with direct costing, there is no volume variance (under-, or overapplied fixed factory overhead).
4. Variable distribution costs, while treated as product costs, are not included in the factory overhead rate because distribution costs are not chargeable to product until sale is made. The costing of variable distribution costs can be accomplished by overhead rate methods or by allocating actual variable distribution costs among the different classes of product (see Fig. 19).

Fig. 16. Overhead rate calculation—direct costing vs. absorption costing.

putation and presentation of net income under two common applications of absorption costing. Part D illustrates the computation of net income and the style of presentation commonly used under direct costing. Part E is a reconciliation of the different profit figures produced by these costing methods.

Cost for Job or Process No. 101 (100 units)	Absorption Costing	Direct Costing
Raw materials	$25.00	$25.00
Direct labor	13.33⅓	13.33⅓
Overhead applied (see Fig. 15 for rates)	Full factory overhead	Variable factory overhead
(A) Rates based on expected activity	46.67 (350%)	26.67 (200%)
(B) Rates based on normal activity	48.00 (360%)	
(C) Rates based on practical capacity	42.67 (320%)	
Cost Shown for Inventory Purposes:		
(A) Rates based on expected activity	$85.00	$65.00
(B) Rates based on normal activity	$86.33	
(C) Rates based on practical capacity	$81.00	
	Full factory cost	Variable factory cost

Notes:

1. Raw materials and direct labor costs are handled in the same way under both methods. The only difference in costing is in regard to factory overhead and distribution costs (see note 3 below).
2. Absorption costing gives the full factory cost of the product, while direct costing gives the variable factory cost. For inventory purposes, absorption costing always provides a higher valuation than direct costing (unless the direct costing figure is adjusted at statement-making time).
3. Some firms would add an allowance to cover distribution costs. If so, this would include both fixed and variable costs in the case of absorption costing but only the variable distribution costs in the case of direct costing. Distribution costs would not be included in inventory values but would be used only for pricing or for judging the relative profitability of individual jobs, products, etc.

Fig. 17. Product cost calculations—direct costing vs. absorption costing.

The situation portrayed in this hypothetical example is fairly realistic, similar to the experience of many firms. As revealed by the operating budget (Part A-1), the company had planned to produce and sell 120,000 units during the year. As shown by the figures in Part A-3, actual production was 122,000 units and actual sales was 121,000 units, so that the year-end ending inventory was 1,000 units. Production and sales varied from one quarter to another so that the size of inventories fluctuated considerably during the year. Costs are assumed to be under control, i.e., actual costs are assumed to behave in the fixed or variable manner planned for at the beginning of the year, so that the only variance forthcoming is volume variance (over-, or underabsorbed fixed factory overhead).

During the first quarter the net income computed under all three methods is the same (see first quarter of parts B, C, and D). In each of the other three quarters, however, the three methods give different net income figures, and the net income for the year differs for each method. These differences are explained subsequently and are reconciled in Part E of Fig. 18.

A. **Basic Data Assumed for Illustration.**

1. Annual operating budget (in absorption costing form with fixed and variable costs separated)

	Total for Year	Average per Quarter	Per Unit
Sales (No. of units)	120,000	30,000	....
Sales (dollars)	$120,000	$30,000	$1.00
Cost of Goods Sold			
Opening inventory	0	0	....
Raw materials used	$ 30,000	$ 7,500	$ .25
Direct labor	16,000	4,000	.13⅓
Overhead (variable)	32,000	8,000	.26⅔
Overhead (fixed)	24,000	6,000	.20
Ending inventory	0	0	....
Total	$102,000	$25,500	$ .85
Gross profit	$ 18,000	$ 4,500	$ .15
Distribution Costs			
Variable	$ 2,400	$ 600	$ .02
Fixed	6,000	1,500	.05
Total	$ 8,400	$ 2,100	$ .07
Operating profit	$ 9,600	$ 2,400	$ .08

2. Overhead rates (see Fig. 16).
3. Actual production and sales in units.

	1st Quarter	2d Quarter	3d Quarter	4th Quarter	Year
Opening inventory	0	0	6,000	2,000	0
Production	30,000	34,000	28,000	30,000	122,000
Sales	30,000	28,000	32,000	31,000	121,000
Closing inventory	0	6,000	2,000	1,000	1,000

B. Income Statement, Absorption Costing, Overhead Rates Based on Expected Activity.

	Quarters 1	2	3	4	Yearly Total
Sales	$30,000	$28,000	$32,000	$31,000	$121,000
Cost of goods manufactured (@ $.85)	$25,500	$28,900	$23,800	$25,500	$103,700
Add opening inventory (@ $.85)	0	0	5,100	1,700	0
Less closing inventory (@ $.85)	0	5,100	1,700	850	850
Cost of goods sold	$25,500	$23,800	$27,200	$26,350	$102,850
Gross profit	$ 4,500	$ 4,200	$ 4,800	$ 4,650	$ 18,150
Under- or overabsorbed fixed overhead	0	800	(400)	0	400
Gross profit adjusted	$ 4,500	$ 5,000	$ 4,400	$ 4,650	$ 18,550
Distribution costs	2,100	2,060	2,140	2,120	8,420
Net operating profit	$ 2,400	$ 2,940	$ 2,260	$ 2,530	$ 10,130

C. Income Statement, Absorption Costing, Overhead Rates Based on Practical Capacity.

	Quarters 1	2	3	4	Yearly Total
Sales	$30,000	$28,000	$32,000	$31,000	$121,000
Cost of goods manufactured (@ $.81)	$24,300	$27,540	$22,680	$24,300	$ 98,820
Add opening inventory (@ $.81)	0	0	4,860	1,620	0
Less closing inventory (@ $.81)	0	4,860	1,620	810	810
Cost of goods sold	$24,300	$22,680	$25,920	$25,110	$ 98,010
Gross profit	$ 5,700	$ 5,320	$ 6,080	$ 5,890	$ 22,990
Under- or overabsorbed fixed overhead	(1,200)	(560)	(1,520)	(1,200)	(4,480)
Gross profit adjusted	$ 4,500	$ 4,760	$ 4,560	$ 4,690	$ 18,510
Distribution costs	2,100	2,060	2,140	2,120	8,420
Net operating profit	$2,400	$2,700	$2,420	$2,570	$ 10,090

Fig. 18. Computation and presentation of net income—direct costing vs. absorption costing.

D. Income Statement, Direct Costing.

	Quarters 1	2	3	4	Yearly Total
Sales	$30,000	$28,000	$32,000	$31.000	$121,000
Variable cost of goods manufactured (@ $.65)	$19,500	$22,100	$18,200	$19,500	$ 79,300
Add opening inventory (@ $.65)	0	0	3,900	1,300	0
Less ending inventory (@ $.65)	0	3,900	1,300	650	650
Variable cost of goods sold	$19,500	$18,200	$20.800	$20.150	$ 78.650
Manufacturing margin	$10,500	$ 9,800	$11,200	$10,850	$ 42,350
Variable distribution costs	600	560	640	620	2.420
Marginal income	$ 9,900	$ 9.240	$10.560	$10.230	$ 39.930
Fixed factory overhead	$ 6.000	$ 6.000	$ 6,000	$ 6,000	$ 24,000
Fixed distribution costs	1,500	1,500	1,500	1.500	6.000
Total fixed costs	$ 7,500	$ 7.500	$ 7.500	$ 7,500	$ 30,000
Net operating profit	$ 2,400	$ 1.740	$ 3,060	$ 2,730	$ 9,930

E. Reconciliation of Profit Figures.

	Quarters 1	2	3	4	Yearly Total
Net operating profit, absorp. cost:					
Using expected activity overhead rates	$2,400	$2.940	$2,260	$2,530	$10,130
Using practical capacity overhead rates	2,400	2,700	2,420	2,570	10,090
Net operating profit per direct costing	2.400	1,740	3,060	2,730	9,930
Fixed expenses for period.					
Using absorption costs, expected activity	$7,500	$6,300	$8,300	$7,700	$29,800
Using absorption costs, practical capacity	7.500	6.540	8,140	7,660	29,840
Using direct costing	7,500	7,500	7.500	7,500	30,000
Reconciliation (Method 1). Note that differences between costing methods in profits is the same as differences in fixed expenses.					
Fixed costs contained in ending inventories.					
Using absorp. costs, expected activity (20¢ per unit)	None	$1,200	$ 400	$ 200	$ 200
Using absorption costs, practical capacity (16¢ per unit)	None	960	320	160	160
Using direct costing	None	0	0	0	0
Change in fixed costs contained in beginning and ending inventories.					
Using absorption costs, expected activity	0	+1,200	−800	−200	+200
Using absorption costs, practical capacity	0	+960	−640	−160	+160
Using direct costing	0	0	0	0	0
Reconciliation (Method 2).					
Net operating profit, expected activity	$2,400	$2,940	$2,260	$2,530	$10,130
Less change in inventory fixed cost	0	1.200	(800)	(200)	200
Equals net operating profit per direct costing	$2.400	$1.740	$3,060	$2.730	$ 9,930
Reconciliation.					
Net operating profit, practical capacity	$2,400	$2,700	$2,420	$2,570	$10,090
Less change in inventory fixed cost	0	960	(640)	(160)	160
Equals net operating profit per direct costing	$2.400	$1,740	$3,060	$2.730	$ 9.930

Fig. 18. (Cont'd.)

Illogical Net Income with Absorption Costing. Proponents of direct costing point out that absorption costing methods often produce illogical net income figures during periods when the volume of production differs significantly from the volume of sales. This is illustrated best in the second and third quarters of the example. There, under absorption costing (see parts B and C), the reported net income was highest during the second quarter when the sales volume was at its lowest point, and the net income was much lower during the third quarter when sales volume was at its highest point. Seemingly illogical net income figures such as these are difficult to explain to nonaccounting people and often lead to misunderstanding or loss of faith in accounting figures.

The explanation of the rather illogical net income which is occasionally experienced with absorption costing is that a certain portion of the **fixed factory overhead costs** is capitalized in the ending inventory figures when absorption costing is used, so that the total amount of fixed factory overhead cost which is charged off against income (under the heading of cost of goods sold or elsewhere) is affected not only by the volume of goods sold but also by the volume of goods produced.

Results such as these are likely to occur with absorption costing whenever the **volume of production** differs significantly from the **volume of sales.** The influence of production volume upon net income is present, regardless of the activity level assumed for overhead rate purposes, although the reported amount of net income is not the same in all cases. The influence even exists when overhead is allocated on the basis of actual production volume, or when cost of sales and inventories are adjusted at the end of the period for over-, or underabsorbed overhead.

With absorption costing, the adverse influences on net income which have been referred to may be avoided by transferring the over-, or underabsorbed fixed overhead (volume variance) to the balance sheet as a deferred charge or credit. This has been advocated by Mauriello (NAA Bulletin, vol. 35) and others. With absorption costing, the income influences which have been referred to can be de-emphasized by carrying the total volume variance (before allocation to inventories and/or cost of sales) down to the last section of the income statement. This has been proposed by Schlatter and Schlatter (Cost Accounting), with particular reference to the use of **practical capacity** overhead rates. Then the net income before correction for volume variance is not influenced by changes in production volume and thus tends to increase or decrease with sales volume. The final net income figure, however, would still be affected.

Methods of Reconciliation of Net Income. The net income figures under absorption costing can be reconciled with those of direct costing in either of two methods:

1. By comparing the fixed expenses, i.e., fixed costs which have been included as expenses of the period.
2. By comparing the change in the amounts of fixed cost which are contained in the beginning and ending inventories.

The **fixed costs** which are included as expenses of a period may be computed as follows:

1. Under direct costing, all the fixed costs incurred during the period are treated as expenses of the period. None are carried over from one period to the next in inventory values.

   Fixed expenses = fixed factory overhead + fixed distribution costs (fixed selling and general administrative costs)

2. With absorption costing, fixed factory costs are charged to inventory through the use of overhead rates and thus become treated as expenses only when the goods are sold. The problem is further complicated by the presence of under- or overabsorbed fixed factory overhead (volume variance), some or all of which influence the amount of fixed costs which is treated as expense of the period. If the company follows the practice of allocating part of overhead variances to inventories, only a part of the volume variance influences the amount treated as expense.

Fixed expenses = fixed costs in the opening inventory
+ fixed overhead applied to production through use of the overhead rate
− fixed cost in the ending inventory
+ under- (or over-) absorbed fixed factory overhead
+ fixed distribution costs

Stated in another way:

Fixed expenses = all fixed costs incurred during the period
+ fixed costs contained in opening inventories
− fixed costs contained in ending inventories

Thus, with absorption costing, the amount treated as fixed expenses in a period is directly related to and affected by the change in the amount of fixed costs contained in opening and closing inventories.

The amount of fixed cost contained in opening and closing inventories is determined by the nature and composition of the overhead rates and can also be influenced by allocations of under- or overabsorbed overhead if the firm follows the practice of allocating these variances between the inventories and cost of sales at the end of each period.

In the example used here, the various costing methods apply different amounts of fixed cost to inventory (see Fig. 16):

	Fixed Costs Included in Inventories
Absorption Costing; expected activity overhead rate ($6,000 ÷ 30,000 units)	$20 per unit
Absorption Costing; practical capacity overhead rate ($6,000 ÷ 37,500 units)	$16 per unit
Direct costing	None

If the example had shown under- or overabsorbed overhead allocated to inventories at the end of each quarter, this would have changed the inventory dollar figures slightly and would have affected the net operating profit figures, but it would not have changed the fundamental nature of the examples.

With regard to the illustrative example, the amount of fixed expense for each quarter under the various costing methods is shown in Part E of Fig. 18. Part E also shows the **fixed costs included in ending inventories** and the change in these figures during each quarter. The different figures for net operating profit are reconciled in Part E by Method 1 and Method 2. By Method 1 the differences in profit are shown to be the same as the differences in fixed expenses. Method 2 uses the reconciliation formula:

Net operating profit (direct costing) = net operating profit (absorption costing)
— change in fixed factory overhead costs contained in beginning and ending inventories

DEVELOPMENT OF DIRECT COSTING. Direct costing seems to be a natural step in the evolution of overhead costing. Over the years a variety of costing methods have gained acceptance only to be replaced by other methods as the nature of management problems changed and a need for new types of information or new forms of information arose.

Prior to 1885, product costs generally were conceived as **raw materials and direct labor costs** only. With increasing complexity in manufacture and trade, business men found need for more complete and refined product costs, particularly for inventory purposes. By the turn of the century, most product costs included **factory overhead** (in whole or in part), as well as the prime costs. In these early efforts to charge factory overhead to product, historical costs were generally used, with inventory values determined at the end of the operating period based on actual materials and labor as well as actual overhead costs. Few companies attempted to maintain a perpetual inventory record in dollars and cents form.

The next development in costing was the use of **predetermined overhead rates** to meet the increasing problems of cost estimating and competitive pricing. Brummet (Overhead Costing) writes:

> At about the turn of the century predetermined overhead rates and problems of idle time began to be given more consideration, especially in this country. The rapid growth of industries and more extensive tapping of our natural resources during the early years of the twentieth century, with a greatly increased production of economic goods, brought about an awareness of competition and the need for up-to-date, complete, and reliable cost information.

With the principle of predetermined overhead rates finally gaining acceptance by 1910, there still was considerable disagreement as to the exact manner of rate computation and use. The main controversies were over two questions: Is it necessary to measure and isolate idle capacity costs? Should over- or under-absorbed overhead be redistributed to products through the use of supplementary rates applied at the end of the period? Each of the following practices was commonly found both with and without supplementary rates:

1. Overhead rates based on previous year's experience.
2. Overhead rates based on expected performance.
3. Overhead rates based on normal operating conditions, usually conceived as an average, of probable future performance.
4. Overhead rates based on optimum operating conditions, usually conceived as full capacity.

Overhead rates of the last three types have continued to be important in product costing. **Standard costing** emerged during the 1920's, while supplementary rates fell into disuse. The popularity of standard costing arose primarily because it met an important management need of focusing attention upon the costs which were out of line. The development of standard costing involved nothing really new for overhead costing, although it did give some impetus to practical capacity overhead rates, since this type of an overhead rate fitted more exactly into the optimum operating-condition concept behind the computed standards.

Overhead costing received much less attention in the accounting literature from 1930 to 1950. During this period other cost accounting techniques saw important new developments to meet managerial problems associated with the growing size and complexity of manufacturing facilities. These developments were particularly noteworthy with regard to **budgeting, break-even point analysis, ratio analysis, profit planning, and distribution cost analysis.**

In the early 1950's, **direct costing** emerged as a new approach to overhead costing. Although the method had been used earlier by a few isolated firms, it had received little attention in the accounting literature. Proponents of the method argued that direct costing did a better job of informing management and that the new method consolidated into the accounting system much that was desirable regarding break-even point analysis, profit planning, and other recently developed tools involving the relationship between volume, costs, and profits.

MANAGERIAL USES OF DIRECT COSTING. The principal problems which management faces are the making of accurate appraisals regarding past performance and the formulation of sound decisions regarding the most advantageous courses of action to be followed currently and in the future. The accountant can assist management in solving these problems by providing factual information at the right time and in a form which is readily usable for the questions at hand. Advocates of direct costing argue that direct costing does a better job of informing management, and many accountants would at least admit that this is one of the strong points of direct costing.

Direct costing is particularly effective in providing and presenting information regarding **cost-volume-profit relationships.** Information of this type is extremely important in selecting products, outlets, markets, etc., and in deciding upon relative emphasis where two or more products, outlets, markets, etc., are used. It is also important in pricing, in budgeting, and in profit planning (see also section on Cost-Volume-Profit Relationships).

Product Contribution to Profits. Fig. 19 shows a typical direct costing income statement by **product class.** The marginal income figures indicate the contribution of each product class toward the recovery of fixed costs and are usually considered to measure profit contribution. Since the amount of fixed cost will not be influenced by selling more or less of any product class, the important point is to determine how much marginal income exists, and whether the total marginal income from all product classes is large enough to cover fixed costs. On this basis in Fig. 19, Product C contributes the most to company profits. Product A is a losing proposition at the moment; company profits would have been $100 higher if no sales had been made in this line. Product B is profitable but does not contribute so much as Product C.

There is another important point of view which can be taken regarding profit contribution. Since certain fixed costs (i e., annual tooling or engineering, product advertising) are so directly involved with each product line that they presumably would be avoided if the product line were dropped, a better measure of the profit contribution of each product line (if each line is to be considered as a whole) is the profit or loss after direct costs. On this basis, Product B contributes the most to company profits, rather than Product C.

These two different points of view are easily reconciled. The first point of view is appropriate when the company is already committed to the retention of a product class or is committed to such an extent that the fixed costs directly related to this course of action cannot be salvaged by dropping the product. The second point of view is appropriate when the company is not yet committed to the course of action but is merely considering the impact of various alternatives.

Fig. 19 involves only an analysis by product line. Precisely the same type of analysis can be made for different markets, sales divisions, outlets, customers, or other subdivisions of over-all company operations. It is also possible to employ a two- or three-way classification in the analysis showing two or three **levels of direct fixed costs.**

Most Profitable Sales Mix. Assuming that there is some unused capacity, additional profits can be realized by increasing the sales of any products (markets, outlets, customers, etc.) showing a positive **marginal income** (Products B and C in Fig. 19) and by decreasing the sales of any products (markets, etc.) showing

	Product A (100 sales units)	Product B (250 sales units)	Product C (600 sales units)	Total
Sales	$1,000	$2,000	$3,000	$6,000
Variable Cost of Sales				
Materials	200	300	300	800
Direct labor	300	300	900	1,500
Manufacturing overhead	400	500	600	1,500
Total	$ 900	$1,100	$1,800	$3,800
Variable manufacturing margin	$ 100	$ 900	$1,200	$2,200
Variable selling and G & A costs	200	100	300	600
Marginal income (loss)	$ (100)	$ 800	$ 900	$1,600
Direct Fixed Costs				
Manufacturing	50	150	300	500
Selling and G & A	50	100	150	300
Total	$ 100	$ 250	$ 450	$ 800
Profit (or loss) after direct costs	$ (200)	$ 550	$ 450	$ 800
Apportioned Fixed Costs				
Manufacturing	$ 100	$ 150	$ 150	$ 400
Selling and G & A	50	100	150	300
Total	$ 150	$ 250	$ 300	$ 700
Net operating profit (loss)	$ (350)	$ 300	$ 150	$ 100

Fig. 19. Direct costing annual income statement by product class.

a **marginal loss** (Product A). This, however, is an oversimplified answer to the question. Increases in sales volume usually are limited by a shortage of one or more operating factors such as direct labor, productive machinery, raw materials, or sales personnel.

When output or sales is limited by **productive factor shortages**, the relative profitability of different products, markets, outlets, customers, etc., should be judged by studying the marginal income per unit of the scarce productive factor. For example, assuming in Fig. 19 that direct labor is the scarce factor, the relative profitability of the different products would be expressed as follows:

Product A: $100 loss ÷ $300 = marginal loss of $.33⅓ per dollar of labor.
Product B: $800 ÷ $300 = marginal income of $2.66⅔ per dollar of labor.
Product C: $900 ÷ $900 = marginal income of $1.00 per dollar of labor.

In this particular situation, Product B makes the most profitable use of the scarce production factor, and thus this product line should be emphasized in order to obtain a more profitable product mix. Assuming that production and sales are limited only by the available $1,500 of direct labor and that the company devotes itself exclusively to the production and sale of Product B, then marginal income will be $1,500 × $2.66⅔, or $4,000, instead of the present figure of $1,600. Of

course the decision to remain in all three product lines may be justified by prospects for the future or by other limiting factors which might take over if the entire productive facilities and sales effort were to be devoted to one product line.

With regard to the problem posed by raw material shortages, Faulkner (NAA Bulletin, vol. 34) comments as follows:

> In times of shortage of copper, whether due to government controls or other reasons, for the Magnet Wire Company to maintain the highest possible dollar profit, it must channel its available copper supply into the products which will show the highest dollar profit margin per pound before fixed costs. The products which return this margin will also enable the company to show the highest total dollar profit after fixed costs.

When the company is not yet committed to the retention of the product line (market outlet, etc.), the analyst must also consider the amount of the scarce factor which is incorporated in direct fixed costs. Another word of caution should be mentioned. In considering expansion or contraction in the sales volume of a particular product line (market, outlet, etc.), the analyst must also consider the impact that this action may have upon sales prices or promotional cost per unit, both for the increment in sales and for the entire sales volume of the product line.

While the examples have shown the analysis only for different product lines, the same type of analysis may be made for different markets, outlets, sales divisions, or other segments of over-all operations.

Relationship of Sales to Net Operating Profit. How many units must be sold to realize a desired net operating profit (or return on investment) from a product line, sales division, or other segment? Questions of this type are not easily answered under absorption costing. With direct costing, however, a solution is easily obtained by dividing the marginal income per unit of product into the desired total marginal income for the product line (i.e., the total which this segment is expected to contribute toward fixed costs and profit). For example, if Product B in Fig. 19 is expected to show a 10 percent return on \$5,000 of fixed assets used in its manufacture, then a sufficiently large number of units must be sold to contribute a marginal income figure of \$1,000. This is computed as follows:

$$\text{Desired marginal income} = \text{profit} + \text{share of apportioned fixed costs} + \text{direct fixed costs}$$
$$= \$500 + \$250 + \$250 = \$1{,}000$$

Then 313 units must be sold to realize this marginal income. This is computed as follows:

$$\text{Required sales volume (number of units) to achieve desired profit} = \frac{\text{desired marginal income}}{\text{marginal income per unit}}$$
$$= \frac{\$1{,}000}{\$800 \div 250 \text{ units}} = \frac{\$1{,}000}{\$\ 3.20} = 313 \text{ units}$$

The analysis may also be made on the basis of sales dollars:

$$\text{Required sales volume (dollars) to achieve desired profit} = \frac{\text{desired marginal income}}{\text{marginal income as a percent of sales}}$$
$$= \frac{\$1{,}000}{\$800 \div \$2{,}000} = \frac{\$1{,}000}{0.40} = \$2{,}500$$

Relationship of Prices or Unit Costs to Profit. By how much will prices (or unit costs) have to be changed in order to achieve a certain profit objective? Questions of this type are answered under direct costing by computing the desired change in marginal income and stating this figure on a per unit basis.

$$\text{Required change in price or unit cost} = \frac{\text{desired change in marginal income}}{\text{number of units to be sold}}$$

In Fig. 20, for example, management might well ask: What increase in price would have to be made for Product A before this product would begin to contribute to company profits? The net loss after direct costs of $200 is the key to the answer. This is the amount by which the sales of Product A fail to cover the direct costs (variable and otherwise) associated with the manufacture and sale of the product. Sales prices would have to be increased so as to bring in $200 additional marginal income before Product A would begin to make a contribution. Assuming that a rise in prices would not result in a drop in volume or a rise in promotional or other expenses, then prices would have to be increased $200/100, or $2.00 per unit. The answer could also be stated as $200/$1,000, or 20 percent. Looking at the question from the point of view of reducing cost, the same profit result could be achieved by reducing variable or fixed direct costs by a total of $200 i.e., $2 00 per unit.

Sales		$ 6.000
Standard variable cost (factory and selling)		4,000
Profit contribution at standard		$ 2,000
Less: Variances from standard variable cost:		
selling expense variances		100
Profit contribution of sales effort		$ 1,900
Less: Variances from standard variable cost:		
factory cost variances		300
Marginal income		$ 1,600
Less: Capacity costs applied to operations:		
Fixed factory costs (based on goods sold)	$ 600	
Fixed selling and G & A expenses	600	
Total capacity costs applied		$ 1.200
Operating income		$ 400
Less: Capacity costs unapplied:		
Fixed factory costs applicable to unsold inventory (increase in inventory)	$ 50	
Fixed factory, selling and G & A costs applicable to unused capacity	250	
Total		$ 300
Net income before income taxes		$ 100

Fig. 20. Direct costing income statement using standard costs to reveal performance of sales personnel and cost of idle capacity.

Profitability of Sales Effort. Fig. 20 illustrates a type of direct cost income statement which is especially useful in judging the performance of sales personnel. This statement utilizes **standard costs** in such a way that the figures leading down to the profit contribution at standard and the profit contribution of sales

effort reflect only the performance of sales personnel. This is possible simply because factory cost variances are not subtracted from profit until a later point. This kind of statement may also be presented by product line, sales territory, salesmen, market, or other subdivision of company operation. A statement of this type can also advantageously show actual figures, budgeted figures, and variations from budget.

Furthermore Fig. 20 illustrates the possibility of combining some of the desirable features of absorption costing with those of direct costing. The determination of the cost of maintaining unused capacity is a feature of absorption costing when **practical capacity overhead rates** are used. In a similar way, practical capacity rates can be used with direct costing so that fixed factory, selling, and general administrative expenses are applied to operations for the actual activity involved and so that the unapplied part of these costs can be determined separately as the cost belonging to idle capacity.

Pricing. Based upon a research study of 18 companies which employ direct costing, the National Association of Accountants reported in NAA Research Series No. 23 (NAA Bulletin, vol. 34):

> In pricing, management must consider the volume of merchandise that can be sold, together with the unit price received, because both these factors affect the amount of profit realized It is evident that unless the combination of price and volume obtainable returns all costs in the long run, there will be no profits For this reason, all costs are alike in their significance for determining costs as guides to long range pricing policy. That this reasoning is applied in practice can be seen in the fact that all the companies interviewed have methods for assigning all costs to product classifications to develop product costs for use in pricing decisions even though inventories are, in some cases, costed at direct cost.
>
> At the same time, pricing is not simply a matter of finding full cost of each product and adding a desired profit. In pricing, costs are often recovered by selling numerous items, some of which contribute more than others, to the portion of the over-all cost which is fixed and joint as to the items within a line. Moreover, the proportions in which individual products contribute to total cost may vary in different markets and at different times.
>
> Unit variable cost has a constant relationship to unit selling price regardless of volume within the limits of available capacity. On the other hand, unit fixed costs do not have a constant relationship to unit selling prices. The best selling price for an individual item is the one which, multiplied by the quantity which can be sold, yields the largest dollar contribution to fixed costs and profits. In practice, this aim can only be approximated because estimates of quantities which can be sold at different prices are largely guesses. Moreover, competition sets definite limits to the possible range of selling prices. Under such circumstances, the principal advantage of direct costing is that it enables management to give separate consideration to variable and fixed portions of a product's cost. Some companies interviewed prefer the direct costing approach in searching for the most advantageous combination of price and volume because absorption costing provides costs for only a single volume.

One of the criticisms frequently raised against direct costing is that it may lead to **unprofitable pricing** through disregard of the need for recovering fixed costs. While this danger may still exist the 18 firms previously referred to avoided this problem by providing full product costs for pricing or by making certain that those who establish company prices fully understood the nature of direct costs. (For additional discussion of pricing, see section on Special Cost Analyses.)

DIRECT COSTING PRECAUTIONS. Although direct costing has been praised by many as a useful tool of management, others have pointed out several

situations where the method must be used with caution. In general the suitability of direct costing data must be decided in the light of the specific managerial problem to be answered.

Fixed Costs Must Eventually Be Recovered. In concentrating upon marginal income and contribution to overhead, fixed costs must not be ignored to the extent that they are not recovered. This is likely to be a problem in pricing unless management thoroughly understands direct costs.

Direct Costing Is Not Marginal Costing. Because direct costing does not properly allow for the fact that volume increases ordinarily are possible only by reducing prices or increasing promotional expenses, the method does not precisely measure the exact impact upon profits of projected changes in volume or prices. Direct costing also does not allow for the fact that changes in volume may also be accompanied by changes in variable cost per unit. In short, direct costing is not the same as the economists' **marginal cost and revenue** approach.

Direct Costing May Not Include All Pertinent "Direct Costs." Direct costing really means **variable costing.** Although reports may include as direct costs those certain fixed costs which may be related directly to significant segments of over-all output, it is difficult if not impossible to allow properly for all such **nonvariable costs.** Those costs which are fixed in relation to the size of a production lot, in relation to the size of a customer's order, or in relation to the volume of a customer's annual purchases are examples of costs which need to be considered as pertinent direct costs for some purposes but not for others.

Errors or Inconsistencies in Classifying Costs. The assumption that all operating costs may be classified as fixed or variable, or partly fixed and partly variable, necessitates arbitrary decisions with regard to many types of **semi-variable costs.** This results in reported variable product costs which are only approximations of the true variable cost. Furthermore, it is assumed that the "fixity" or invariability of costs will hold true throughout a wide range of possible price, product, output combinations.

Changes in Variable Product Costs. Because of changes in organization and operating policy and the impact of these upon cost behavior, the exact categories of costs which are classified as fixed or as variable may change from year to year. If there are significant changes in the composition of the variable costs used for inventory valuation purposes, these costs may prove to be confusing when tracing past developments or when making plans or decisions regarding the future.

Effect of Adjustment Time on Expense Variability. Moss and Haseman (Accounting Review, vol. 32) and others have called attention to the fact that for long term planning, most of, if not all, the fixed costs should be considered as variable, since there is sufficient time to adjust them to meet the intended volume of output.

Joint Products Considered Together. Where a group of products are produced together in somewhat fixed proportions, it is not worth-while, and is even likely to be misleading, to apply direct costing to the individual products. This is true because the decision to produce more of one of the joint products necessarily involves producing more of the others, so that price-output decisions must be formulated for the products as a group.

Creep of Unnecessary Costs. A possible danger in overemphasizing the **contribution to overhead** approach is that the encouragement to take on business

which barely covers variable cost may be so strong that when an opportunity for higher profit business arises it may lead to an expansion in organization and facilities with its attendant fixed costs. In many cases such an expansion would be unnecessary if the low-contribution business could be dropped and such action often would be more profitable. Dixon (Journal of Accountancy, vol. 98) has referred to this situation in an article appropriately titled "Creep."

Foresight Needed. The most ingeniously conceived records of past cost are not an accurate forecast of the future. This applies to absorption costing as well as direct costing. Since a large part of the decisions made by top management hinges upon the probable course of future events, there is a definite limit to the usefulness of further refinement of historical cost data. Hepworth (Accounting Review, vol. 29) has stated this problem as follows:

> It seems essential to recognize that the appropriate costs to consider in the formation of policies affecting future actions are expected future costs and not the recorded historical costs of past periods. This means that policy decisions should be based upon the results of analytical activity supplementary to the historical accounting records.

ALTERNATIVES TO DIRECT COSTING. The choice in costing methods is not simply between direct costing and absorption costing. There are a number of variations in both these methods.

Statistical Calculation of Marginal Cost as Needed. When absorption costing methods are used, the cost accountant may still undertake special studies, as necessary, to determine the amount by which total cost has been or will be changed as a result of some increase or decrease in volume or as a result of some other contemplated action. The results of such studies may be reported to management as supplements to the regular accounting reports. These marginal cost reports may follow the general format of the **direct costing income statement** (Figs. 19 or 20), or they may simply be reports of marginal and full cost by product, process, sales division, etc. This is the general procedure which has been followed for some years in regard to break-even charts, profit-volume analysis, etc.

Multiple Classifications of Operating Costs. With the advent of electronic data processing equipment, vastly more complicated classifications of operating costs are feasible to meet the needs of management in answering such questions as, "What will happen to costs, profits, cash position, etc., if some contemplated change in operations is carried through?" As an alternative to direct costing, Greer (NAA Bulletin, vol. 35) has pointed out the need for multiple classifications of costs. In referring to the usual classifications of costs by type (natural classification) and by function (departmental or cost center), he says:

> This, however, is only the beginning of an adequate analysis of costs and expenses. As to each activity (cost center), a distinction must be made between direct and apportioned charges, between standard and allowable expense, between fixed current and fixed sunk costs, and between those outlays which are presently controllable at the local level and those which reflect management decisions made at some earlier time or in some higher echelon.
>
> Such analyses give rise to a series of internal cost reports which are vital to intelligent control of activities and evaluation of results, while, at the same time, contributing the elements necessary to a calculation of product costs, stated in whatever terms may be most useful for the management's immediate purposes. A glance at the report for any individual cost center will show the probable cost influence of any

additions to (or reductions in) the volume of any product utilizing the facilities of that center and will suggest the advantage or disadvantage of any price decision of either short range or long range import.

Absorption Costing with Practical Capacity Overhead Rates. Schlatter and Schlatter (Cost Accounting) argue that the proper use of overhead rates based on practical capacity offers a good solution to management's need for cost-volume-profit information. Under this approach, it is true that profits are influenced by both sales volume and production, but an explanation of the secondary impact of volume of production upon profits is provided by the **volume variance** figure which, under the practical capacity concept, measures the cost of providing and maintaining unused manufacturing capacity. To answer management's need for marginal cost information, Schlatter and Schlatter would provide supplementary studies based upon differential cost analyses.

	Product A (10,000 sales units)	Product B (6,000 sales units)	Total
Sales	$20,000	$18,000	$38,000
Less: Cost of sales			
Raw materials used	$ 2,000	$ 2,000	$ 4,000
Direct labor	3,000	2,000	5,000
Variable overhead applied	3,000	2,500	5,500
Variable cost of sales	$ 8,000	$ 6,500	$14,500
Fixed overhead applied	3,000	2,500	5,500
Total Cost of Sales	$11,000	$ 9,000	$20,000
Gross Profit	$ 9,000	$ 9,000	$18,000
Less: Operating expenses			
Variable selling and G & A expenses	$ 2,000	$ 1,500	$ 3,500
Fixed selling and G & A expenses	3,000	1,500	4,500
	$ 5,000	$ 3,000	$ 8,000
Net Profit from Operations	$ 4,000	$ 6,000	$10,000
Less: Other expenses			
Underapplied overhead			
Variable factory overhead	$ 1,000	$ 1,000	$ 2,000
Fixed factory overhead	1,000	1,000	2,000
Net total	$ 2,000	$ 2,000	$ 4,000
Net Income Before Income Taxes	$ 2,000	$ 4,000	$ 6,000
Recapitulation			
Sales	$20,000	$18,000	$38,000
Variable costs	11,000	9,000	20,000
Marginal income	$ 9,000	$ 9,000	$18,000
Fixed costs	7,000	5,000	12,000
Net Income Before Income Taxes	$ 2,000	$ 4,000	$ 6,000

Fig. 21. Absorption costing income statement by product line with separation of fixed and variable costs.

Absorption Costing with Separation of Fixed and Variable Costs. By maintaining records which separate fixed and variable costs, absorption costing reports can be prepared from the accounts so as to reveal the marginal cost information so helpful to management in gaging cost-volume-profit relationships. Fig. 21 illustrates such a report. To permit easy preparation of such reports, overhead rates should be broken down into fixed and variable components, and (in the accounts) fixed and variable costs should be separated for factory overhead, selling, and general administrative expenses, and also for work in process, finished goods, and cost of sales.

Direct Costing with Year-End Adjustments to Absorption Costing Base. Since the main objections to direct costing have been because of its effect upon inventory valuation and reported profits, a compromise alternative solution, proposed by Marple (Accounting Review, vol. 30) and others, is to adjust the **inventory** and **net income** figures just prior to the preparation of published financial reports. Using this alternative, internal records and reports would still be maintained during the year on a direct costing basis in order to present product-cost-volume-profit information in a more readily understandable form.

Formula for Year-End Adjustment. The adjustment of inventories from direct costing to absorption costing must take into account the fixed factory costs allocable to the units in the beginning and ending inventories for work in process and finished goods. This may be determined on an **overhead rate basis** as follows:

$$\text{Fixed factory costs per direct labor hour, direct labor dollar, machine hour, or unit} = \frac{\text{total fixed factory overhead for the period}}{\text{total direct labor hours, direct labor dollars, machine hours, or units produced}}$$

The amount allocable to the inventory is computed by multiplying the rate, as determined by the preceding formula, by the direct labor hours, direct labor dollars, machine hours, or units contained in the inventory.

The actual amount of the adjustment to the ending inventory must take into consideration the fact that the fixed factory costs for the beginning inventory are already on the books as a result of the adjustment of the previous period. The actual amount of the adjustment, therefore, is as follows:

$$\text{Net change in inventory and profits} = \text{fixed costs allocable to ending inventories} - \text{fixed costs already allocated to beginning inventories}$$

If the formula gives a positive figure, the adjustment should be added to the inventory and profits. If the formula gives a negative figure, the adjustment should be subtracted from the inventory and profits.

One way of presenting the direct costing data adjusted to an absorption costing basis is shown in Fig. 22.

CONFORMITY WITH ACCEPTED ACCOUNTING PRACTICE. Although direct costing has been accepted by many for internal reporting, it has not received the same degree of acceptance for external reporting. The principal criticisms have been leveled at the effects of direct costing upon **inventory valuation** and **net income determination.** These effects have been examined earlier (see Fig. 18).

Net sales		$950,000
Less: standard variable cost of sales		475,000
Manufacturing margin		$475,000
Variable selling expenses		47,500
Distribution margin		$427,500
Operating variances		4,500
Marginal income		$423,000
Less: Fixed costs		
Production	$200,000	
Selling expenses	75,000	
Administrative expenses	50,000	
Other expenses	25,000	
Total fixed costs		$350,000
Direct cost operating profit		$ 73,000
Less: Reduction of fixed costs in inventory		10,000
Absorption cost operating profit		$ 63,000

Fig. 22. Direct costing income statement adjusted to an absorption costing basis.

The American Institute of Certified Public Accountants and the American Accounting Association have taken the position that direct costing is not acceptable for purposes of inventory valuation and net income determination. Rulings of the Internal Revenue Service also seem to take the view that direct costing is not ordinarily acceptable for income tax purposes.

Position of the American Institute of C.P.A.'s. The position of the Committee on Accounting Procedure of the American Institute of C.P.A.'s is set forth in Accounting Research Bulletin No. 43. While this bulletin does not specifically mention direct costing, it does state that the primary objective of **accounting for inventories** is the proper determination of income through the matching of costs and revenues, and that in order to accomplish this purpose, product costs should include the sum of the applicable expenditures and charges directly or indirectly incurred in bringing an article to its existing condition and location. This would appear to include fixed as well as variable factory overhead costs and would thus invalidate direct costing.

In discussing the problem further, Bulletin No. 43 appears to hedge its position somewhat by stating:

> Under some circumstances, items such as idle facility expense, excessive spoilage, double freight, and rehandling costs may be so abnormal as to require treatment as current period charges rather than as a portion of the inventory cost. . . . It should also be recognized that the exclusion of all overheads from inventory costs does not constitute an accepted accounting procedure.

It has been inferred from this position that the exclusion of fixed costs from inventory values still lies within the bounds of acceptable practice, and that direct costing is therefore an acceptable procedure. This does not appear to be the intent of these passages, however, since such an interpretation would be at variance with the primary statement regarding the matching of cost and revenue.

Position of the American Accounting Association. The position of the Committee on Accounting Concepts and Standards of the American Accounting Association (Accounting and Reporting Standards for Corporate Financial Statements and Preceding Statements and Supplements) is stated as: "Thus the cost

of a manufactured product is the sum of the acquisition costs reasonably traceable to that product and should include both direct and indirect factors. The omission of any element of manufacturing cost is not acceptable." This is clearly a denial of the acceptability of direct costing, since direct costing would require an omission from inventory of all fixed manufacturing costs.

DIRECT COSTING AND INCOME TAX LAW. The Internal Revenue Code does not specifically prohibit the use of direct costing for income tax purposes, nor does the Code state just how overhead costs are to be reported. The Code (Federal Taxes 1958) does state, however, that the cost of inventories of products manufactured by the taxpayer must include materials, labor, and overhead, including a reasonable proportion of management expenses, and that the inventory must conform to the best accounting practice in the trade or business and must clearly reflect the income of the enterprise. The ruling of the Internal Revenue Service also seems to be that direct costing does not conform to the best accounting practice and is therefore not acceptable for income tax reporting. This is particularly the case when a firm seeks to change to direct costing from a currently acceptable method. It is not clear, however, whether a firm that has previously been filing under direct costing will be required to change to another method.

ADVANTAGES AND DISADVANTAGES OF DIRECT COSTING. In NAA Research Series No. 23 (NAA Bulletin, vol. 34), the following advantages and disadvantages of direct costing are listed:

Advantages of Direct Costing:

1. Cost-volume-profit relationship data wanted for profit planning purposes are readily obtained from the regular accounting statements. Hence management does not have to work with two separate sets of data to relate one to the other.
2. The profit for a period is not affected by changes in absorption of fixed expenses resulting from building or reducing inventory. Other things remaining equal (e g., selling prices, costs, sales mix), profits move in the same direction as sales when direct costing is in use.
3. Manufacturing cost and income statements in the direct cost form follow management's thinking more closely than does the absorption cost form for these statements. For this reason, management finds it easier to understand and to use direct cost reports.
4. The impact of fixed costs on profits is emphasized because the total amount of such cost for the period appears in the income statement.
5. Marginal income figures facilitate relative appraisal of products, territories, classes of customers, and other segments of the business without having the results obscured by allocation of joint fixed costs.
6. Direct costing ties in with such effective plans for cost control as standard costs and flexible budgets. In fact, the flexible budget is an aspect of direct costing, and many companies thus use direct costing methods for this purpose without recognizing them as such.
7. Direct cost constitutes a concept of inventory cost which corresponds closely with the current out-of-pocket expenditure necessary to manufacture the goods.

Disadvantages of Direct Costing:

1. Difficulty may be encountered in distinguishing the fixed costs. In particular, certain semi-variable costs may fall in a borderline area and more or less arbitrary classification may be considered necessary in order to arrive at a practical determination of fixed and variable components.

2. Complete manufacturing cost is not determined in the process of costing production, and supplementary allocation of fixed overhead on normal or some other volume base must be made to provide product costs for long-range pricing and other long-range policy decisions.
3. Serious income tax problems may be encountered if a change is made from full cost to variable cost for costing inventory and definite rulings are not available for guidance.
4. Some accountants question the acceptability of direct cost as a basis for costing inventory in financial statements prepared for stockholders and the public at large. However, extensive interest in direct costing has arisen very recently and opinion with respect to this question has not crystallized.

Mauriello (NAA Bulletin, vol. 35) concludes a discussion of direct versus absorption costing as follows:

> To say that one type of costing is superior to the other, presumes the existence of an issue when there is none. What appears to be an issue between two cost systems is, in reality, a recognition of the need for distinguishing between variable and fixed costs. Ingenuity in the use of both types of costing will disclose a high degree of fluidity and interchangeability. Each type possesses desirable features which the other lacks. Yet each type can be so controlled and regulated as to produce the results of the other, without losing the advantages inherent in the particular type. It cannot be stressed too much that the use of either direct costing or conventional costing is a matter of choice for the particular situation, rather than of innate superiority of one over the other. One who installs either type of system should keep in mind the need for flexibility, so that adjustment can be made readily to achieve the accomplishments of the other type.

Summary of Methods for Applying Overhead to Products

COMPARISON OF OVERHEAD FORMULAS. Fig. 23 lists the methods of computing rates for the application of overhead and the conditions advantageous for their use. It must be noted, however, that an overhead rate structure cannot be adequately evaluated unless all the particulars regarding it are set forth. It is not sufficient to consider an overhead rate method simply as the "direct labor dollar method" or as the "departmental rate method." There are at least seven characteristics which may differ from one rate to another, and in order to understand fully the overhead rate structure in use, the underlying concepts with regard to all characteristics of the method must be considered.

CHARACTERISTICS OF A GOOD METHOD. Neuner (Cost Accounting) lists the following characteristics of a good overhead rate method:

1. It should be easily computed.
2. It should be inexpensive to use in applying it to the cost of production.
3. It should have some relation to the time factor involved in many indirect costs.
4. It should be computed on a departmental basis, if possible, so that the causes of variances can be localized.
5. It should be reasonably accurate, i.e., representative of the estimated overhead costs applicable to each unit.

With regard to the accuracy of the overhead rate, certain points may provide a general guide:

1. The method selected should use as its base the main productive element in the particular manufacturing operation; i.e., it should relate indirect factory costs to the product in a logical way.

Method	Formula		Where Useful
1. Direct Labor Dollar	$\dfrac{\text{Overhead}}{\text{Direct labor dollars}}$	= percent of overhead per direct labor dollar	Labor the main productive element; no material pay rate differences.
2. Direct Labor Hour	$\dfrac{\text{Overhead}}{\text{Direct labor hours}}$	= rate per direct labor hour	Labor the main productive element; pay rate differences preclude using (1).
3. Machine Hour	$\dfrac{\text{Overhead}}{\text{Machine hours}}$	= rate per machine hour	Machines the main productive element; no uniform relationship between machine time and man time.
4. Unit of Product	$\dfrac{\text{Overhead}}{\text{Number of units of product (each, weight, points)}}$	= overhead cost per unit of product	One product mass-produced; or a few products of great uniformity that can be related by weight or by a point system.
5. Materials Cost	$\dfrac{\text{Overhead}}{\text{Direct materials cost}}$	= percent of overhead per direct materials dollar	Most useful to apply material burden; also, in special departments and for special processing of materials.
6. Prime Cost	$\dfrac{\text{Overhead}}{\text{Direct materials cost} + \text{Direct labor cost}}$	= percent of overhead per dollar of prime cost	In special situations only; material and labor costs, together, should follow a uniform pattern; considered antiquated.
7. Market Value	$\dfrac{\text{Market value, Product A}}{\text{Total market value, all products}}$	= percent of overhead apportioned to Product A	For joint products.
8. Moving Average Rate	$\dfrac{\text{Average monthly overhead of past 12 mos.}}{\text{Estimated direct labor hours or dollars or machine hours for next month}}$	= new rate for the month per productive factor	To base overhead on actual costs and yet smooth out some month-to-month cost fluctuations.
9. Blanket Rates	$\dfrac{\text{Total overhead for plant}}{\text{Total hours, dollars, or units}}$	= blanket rate	Where one product is made in continuous process; where a few related products are made, involving the same time and effort at each stage.
10. Departmental Rates	$\dfrac{\text{Direct department overhead} + \text{apportioned overhead}}{\text{Hours, dollars, or units for department}}$	= departmental rate	Where diverse products are made; where differences in processing occur.

Fig. 23. Summary of overhead formulas and their use.

Method	Formula	Where Useful
11. Departmental Hourly Cost Rate	$\dfrac{\text{Direct labor cost for department} + \text{departmental overhead}}{\text{Hours, dollars, or units for department}} = \text{departmental hourly cost rate}$	Where departmental rates are used and ease of calculating unit costs is desired; where direct labor as a separate element becomes less distinct.
12. Cost Center Rates	$\dfrac{\text{Direct overhead for cost center} + \text{apportioned overhead}}{\text{Hours, dollars, or units for cost center}} = \text{cost center rate}$	Where departmental rates are not accurate; i.e., departments not homogeneous cost units.
13. Cost Center Hourly Cost Rate	$\dfrac{\text{Direct labor cost for cost center} + \text{cost center overhead, direct and apportioned}}{\text{Hours, dollars, or units for cost center}} = \text{cost center hourly cost rate}$	Where cost center rates are necessary and ease of calculating unit costs is desired; where direct labor as a separate element is less distinct.
14. Overhead Rates by Product Line	$\dfrac{\text{Overhead allocated to product line}}{\text{Hours, dollars, or units for product line}} = \text{rate for the product line}$	Where differences in the overhead requirements of the different products is not accurately reflected in any single common denominator (hours, labor dollars, or units). Research and development costs, tooling, materials handling.
15. Overhead Rates by Productive Factor (materials, labor, and facilities)	$\dfrac{\text{Overhead related to the productive factor}}{\text{Hours, dollars, or units of the productive factor}} = \text{rate for the productive factor}$	Where products differ regarding the relative importance in manufacture of materials, labor, and machine facilities and where these differences cannot be properly handled by departmental or plant-wide labor-related overhead rate supplemented by cost center facility-related overhead rates.
16. Service Department Overhead Rates	$\dfrac{\text{Direct departmental overhead} + \text{apportioned overhead}}{\text{Hours, dollars, or units}} = \text{service department overhead rate}$	To distribute overhead to using departments, where the producing department overhead rate bases are not appropriate for the particular function. Materials handling costs, research and development, inspection, tooling and tool setup.

17. Fixed Overhead Rates and Variable Overhead Rates	$\frac{\text{Fixed overhead}}{\text{Hours, dollars, or units}}$	= fixed overhead rate	To distribute overhead to using departments, as an alternative to direct costing, to allow fixed costs to be applied on one base and variable costs on another.
	$\frac{\text{Variable overhead}}{\text{Hours, dollars, or units}}$	= variable overhead rate	
18. Normal Rates	$\frac{\text{Budgeted overhead at normal capacity}}{\text{Normal production in hours, dollars, or units}}$	= normal rate	Where it is desired to eliminate from unit costs and inventories fixed charges applicable to excess capacity; where it is desired to level unit costs for overhead over a period of years (possibly the business cycle).
19. Practical Capacity Rates	$\frac{\text{Budgeted overhead at practical capacity}}{\text{Practical capacity in hours, dollars, or units}}$	= practical capacity rate	Where it is desired to eliminate from unit costs and inventories all fixed charges representing capacity not used in production.
20. Standard Rates	$\frac{\text{Standard overhead for normal activity (or practical capacity)}}{\text{Standard hours, dollars, or units for normal activity (or practical capacity)}}$	= standard overhead rate	When a standard cost system is used. (See sections on Setting Standard Costs and Operation of Standard Costs.)
21. Standard Productive Hour	$\frac{\text{Standard direct labor dollars + normal overhead, direct and apportioned}}{\text{Standard productive hours}}$	= standard rate per standard productive hour	Combines advantages of standard rates with cost center hourly rates. (May also be computed for practical capacity.)
22. Supplementary Rates	$\frac{\text{Actual overhead − absorbed overhead}}{\text{Hours, dollars, or units}}$	= supplementary rate	To obtain actual overhead cost for product where a predetermined rate has been used; to modify costs during period without changing main rates; to correct for grossly miscalculated overhead rates.
23 Direct Costing Rate	$\frac{\text{Variable overhead}}{\text{Hours, dollars, or units}}$	= direct costing overhead rate	With a direct costing accounting system; where product costs represent out-of-pocket, or marginal, costs.

Fig. 23. (Cont'd.)

2. Separate rates should be established for each area that constitutes a homogeneous cost unit from the point of view of obtaining correct product costs. In some cases, this may mean cost center or operation rates; in others, blanket rates.
3. The method should eliminate from product cost unwarranted fluctuations in unit costs brought about by radical volume changes. In some companies this problem may not exist in excessive form, and actual, or an estimate of actual, rates may suffice. In a majority of companies, normal rates or practical capacity rates are necessary.
4. The method or methods adopted should make possible monthly profit and loss statements of operating significance, as well as facilitate the compilation of special reports.
5. Other things being equal, departmental rates or cost center rates are superior to blanket rates because of the greater accuracy of the former.
6. Other things being equal, rates based on time (labor hours, machine hours, etc.) are preferable to rates based on a variable cost factor (labor dollar, materials cost, etc.). This is because many important expense items, particularly fixed charges, are functions of time (depreciation, fire insurance, rent, etc.), and cost factors may not move in step with changes in overhead.
7. The method adopted should be practical; but not so practical as to give the wrong cost data or so simple as to yield information of no use.

In the final analysis, the method of applying overhead to the product must be tailor-made for each organization. The best method probably will be discovered only after considerable experimentation.

SECTION 10

MANUFACTURING OVERHEAD AND NORMAL ACTIVITY

CONTENTS

CONTENTS (*Continued*)

SECTION 10

MANUFACTURING OVERHEAD AND NORMAL ACTIVITY

Normal Overhead Costs

CONCEPT OF NORMAL OVERHEAD. The basic concept of normal overhead costs is that costs charged to products should be estimated, allowable, or budgeted normal costs at normal activity levels rather than actual costs at actual activity levels. The technique used to make normal overhead cost assignments involves **normal overhead rates.** These rates are determined by relating normal overhead costs to normal production activity levels.

NORMAL COSTS AND ACTUAL COSTS. Although the practice of assigning actual overhead costs to processes and even to jobs is still used by some firms, the more common practice is to apply **pre-established or budgeted overhead costs.** Neuner (Cost Accounting) states: "In arriving at the total cost of manufacture for the units of an order, cost accountants use an estimated or budgeted or predetermined overhead rate to compute the amount of indirect manufacturing costs chargeable to each job order."

Vatter (Managerial Accounting) emphasizes the use of normal costs:

> The need for unit cost figures is not one that can be met by making assignments of actual costs incurred to the product cost units. . . . Since there is no way in which a specific indirect cost, such as the cost of lighting the work places or the salary of the supervisor, can be assigned to a single unit of product, or even a "block" of production such as a line or class of product, or a specific production order or lot, it is necessary to rely upon averaging of some sort . . .

This averaging procedure generally utilizes normal costs rather than actual costs.

NEED FOR NORMAL COST INFORMATION. Accountants and business managers agree generally that normal overhead cost information is necessary and preferable to actual overhead cost data for both **management control and planning** and for **financial statement presentation.** In a work prepared by the Machinery and Allied Products Institute (MAPI Accounting Manual), normal cost information based on normal volume is recommended "because conditions of production and distribution in the machinery manufacturing industries vary so greatly that costs obtained by using current actual ratios for factory expenses (which may be temporarily high or low) can result in questionable and misleading valuations for inventories, costing, estimating, and pricing." Conditions may vary to a greater extent in the machinery manufacturing industry than in many industries. Nevertheless the erratic nature of many overhead costs, the practical inability to time precisely the recognition of costs, and at least some variability of volume make normal cost information necessary.

Vatter (Managerial Accounting) advocates the use of **normal costs for financial reporting** as follows:

From the viewpoint of income measurement and inventory valuation, it is clear that a firm whose peak production activities immediately preceded the close of the year would show a lower unit cost than would be the case if the last months were at low levels of output. Hence, unless the costs of the entire year were averaged, it would hardly be possible to show a representative cost in the inventory calculation.

The Committee on Research of the National Association of Accountants in Research Series No. 24 (NAA Bulletin, vol. 34) states:

Over the long run, management's pricing objective is to obtain prices for the company's products which will return all costs and provide an adequate return on capital invested. For such a purpose, long-run normal, or average cost of the product constitutes a better guide than does the cost which prevails in any given short period.

SIGNIFICANCE OF TIME SPAN FOR NORMALIZATION. Applying normal overhead costs to products is accomplished by use of **normal overhead rates.** Such rates are determined by calculating the ratio between normal overhead costs for a time interval and a measure of activity for the same time span. The selection of a reasonable length of time for which to calculate normal overhead rates is of prime significance. The longer the time period used in determining rates, the greater is the averaging or stabilizing effect upon overhead charges per unit of product, and vice versa. Thus, if the **time interval** chosen is only one or a few months, product overhead charges will be averaged over that time period. Seasonal fluctuations of costs and activity levels and inaccuracies of monthly cost recording will be reflected in unit costs rather than being "normalized."

The use of **yearly intervals** is the usual practice. By such a procedure the effects of seasonal and calendar variations are smoothed. In certain industries where long-range planning and commitments are common, a period of more than one year is sometimes used for "normalizing" overhead. A period approximating the expected length of the business cycle may be justified. Brummet (Overhead Costing) states:

Overhead charging rates should be established for income determination purposes using the "long-term" planned utilization which is relevant to decisions to enter into fixed cost commitments. The time period used should approximate the average time period for which fixed commitments are made. In most industries such a period would surely involve at least three to five years.

No fixed rule is available for determining the time span to be used for calculating normal overhead rates. Consideration should be given to fluctuations of plant operations with respect to general business conditions. In many situations normal production costs are determined to reflect the span of the **business cycle** and even forecasts of the next business cycle. In this way normal overhead costs may reflect actual and anticipated changes in classes of work or volume of operations. Thus the concept of normal costs changes with the times as well as with the purposes for which cost information is accumulated.

Normal Activity Levels

CONCEPTS OF NORMAL ACTIVITY. In order to calculate overhead charging rates, it is necessary to determine normal activity levels. The term "normal capacity" is often used to refer to a normal activity level. Accounting

practices and accounting literature reflect several different concepts of normal activity or normal capacity. Various concepts are reflected in the following statements:

> Normal capacity may be defined as that capacity of a plant at which it produces a physical volume of goods sufficient to meet the average sales demand over a period of time long enough to level out the peaks and valleys resulting from seasonal and cyclical causes. (Lang–McFarland–Schiff, Cost Accounting.)

> . . . normal capacity is obtained by listing the expected quantities of each product to be manufactured in a "normal" month or year, the total volume usually being approximately 80 percent of the maximum possible output of the plant. (Henrici, Standard Costs for Manufacturing.)

> The term "normal capacity" is difficult to define or formulate because of uncertainty as to what is normal. . . . In some respects it is sufficiently accurate to say that normal capacity is the estimate of a qualified authority as to the amount of production that should usually be secured in a factory. (Lawrence, Cost Accounting, revised by Ruswinckel.)

> The normal capacity concept consists of two concepts: (1) the long-term concept which relates the selling phase of the business to the production phase over a long period of time, leveling out fluctuations that are of short duration and of comparatively minor significance; (2) the short-term concept which is helpful to management in analyzing changes or fluctuations that occur during an operating year. (Matz–Curry–Frank, Cost Accounting.)

> Because of a more or less fundamental difference of opinion on the definition of a "normal rate of activity," there are two interpretations of the theory of normal burden. To perhaps a majority of cost accountants, normal rate of activity means an average rate based on sales orders expected in a number of future years . . . To others, normal rate of activity means not an average rate based on expected sales volume of a period of future years but the rate at which the factory is equipped to operate—the rate at which production is most economical—the rate at which it would operate if there were no lack of sales orders. (Schlatter and Schlatter, Cost Accounting.)

DETERMINANTS OF NORMAL ACTIVITY. The determination of normal activity involves the measurement of **physical capacity** to produce goods, and **ability to sell** the firm's products, or both. The normal-activity concept held by the management of the firm or by the industry, and the emphasis to be given to particular uses of product cost data usually determine the degree of relevance given to each of these measurements.

The terms "normal capacity" or "normal activity" are often applied to the results no matter whether emphasis is given to plant capacity or ability to sell. It is preferable, however, to refer to the measurement of capacity to produce goods as "practical plant capacity" and to use "activity based on normal sales expectancy" for the measurement of ability to sell. Fig. 1, adapted from Lang–McFarland–Schiff (Cost Accounting), illustrates relationships between successive activity level concepts.

Theoretical Maximum Plant Capacity. The maximum possible or theoretical capacity of a plant or department to produce goods would be that achieved under 100 percent operating time. This involves no limitation for waits and delays of any character or for shutdowns on week ends or holidays. It reflects no regard for sales expectancy. This maximum activity level is greater than a practical goal. It cannot be reached in an actual situation and accordingly is seldom,

if ever, used. It does, however, generally provide a determinable starting point from which departures may be measured in quantifying other concepts of plant capacity levels and of normal activity levels. The chart in Fig. 1 shows theoretical maximum plant capacity as line *AB*.

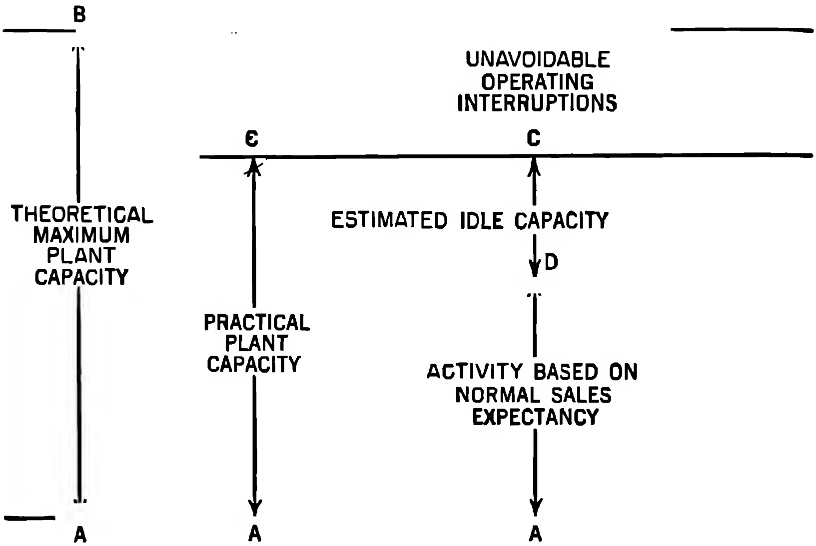


Fig. 1. Relationships of activity levels.

Practical Plant Capacity. When a normal activity concept is related primarily to physical production facilities rather than to sales expectancy, the measurement used is usually referred to as **practical capacity.** This practical plant capacity is theoretical maximum plant capacity less unavoidable operating interruptions. It is shown by line *AC* in Fig. 1. As stated by Matz–Curry–Frank (Cost Accounting),

> . . . Allowances must be made for the unavoidable interruptions, such as time lost for repairs, inefficiencies, breakdowns, setups, failures, unsatisfactory materials, delay in delivery of raw materials or supplies, labor shortages and absences, Sundays, holidays, vacations, inventory taking, and pattern and model changes. These allowances reduce theoretical capacity to a level often called the practical capacity level. It should be noted that this reduction is based on internal influences and does not consider the chief external cause, lack of customers' orders. The reduction from theoretical capacity to practical capacity ranges from 15 to 25 percent, which results in a practical capacity level of 75% to 85% of theoretical capacity.

Although there appears to be some general use of 75% to 85% of maximum activity levels as practical capacity, the exact relationship of practical plant capacity to theoretical maximum plant capacity depends upon the nature of the industry and the circumstances in which a particular firm is situated.

Departmental Capacities and the Unbalanced Plant. Overhead rates may be determined on a **plant-wide basis** or on a **departmental basis.** If departmental rates are used, it is necessary to determine normal activity levels for each

department. If there is perfect balance among departments so that the full capacity of the plant represents the combined full capacities of the departments, no special problems arise. There is, however, usually some out-of-balance of departmental capacities. Two possibilities are presented: (1) Normal capacity for each department may be set without regard to its relation to other departments in the plant; or (2) the normal capacity of the "bottleneck" department may be set, and all other departments related to that normal. Under the first alternative, **excess capacity costs** caused by lack of balance among departments is allowed to remain in the departmental accounts rather than being charged to products. Under the latter approach, additional excess capacity costs caused by **lack of balance** among departmental capacities are assigned to products. The problem is complicated further by the availability of an outside market for, or an outside supply of, **partly processed goods.**

Schlatter and Schlatter (Cost Accounting) illustrate this **departmental out-of-balance** problem and comment on its solution as follows:

> If Department A has a capacity of, say, 10,000 units and Department B a capacity of 15,000 units, there is an unbalanced condition; and Department B cannot operate at more than two-thirds capacity, under the assumption, of course, that Department B has no other source of material on which to work. Whether the normal capacity of B should be set at 10,000 or at 15,000 units is a question on which cost accountants are not entirely in agreement.
>
> If the normal capacity of Department B is taken to be 15,000 units, one-third of its fixed burden will be left in the burden balance, and only two-thirds will find its way into the stated cost of the product, even with the best possible operation under this unbalanced condition.
>
> This method has an advantage in that it does not charge the product with costs of capacity never used in making the product but shows up the loss caused by the inefficiency of management in overequipping Department B or in underequipping Department A.
>
> If the normal capacity of Department B is taken to be but 10,000 units, all the fixed burden of its full capacity will be absorbed into the product costs when production is but 10,000. If there is any likelihood of an attempt to base selling policies on only the manufacturing costs of products without considering the burden losses revealed by the use of the first method, then, perhaps, this second method may be the better one. Here, as in many other cases, the cost accountant, before he can decide upon a course of action, must consider the manner in which the information he furnishes to the management will be used.

Normal Sales Expectancy. Fig. 1 shows activity based on normal sales expectancy as line *AD*, which represents practical plant capacity less estimated idle capacity. Matz–Curry–Frank (Cost Accounting) point out that:

> The majority of firms find it necessary to modify this practical capacity further by considering the utilization of the plant or the various departments in the light of meeting the average commercial demands or sales over a period long enough to level out the peaks and valleys which come with seasonal and cyclical variations. This latter problem leads many firms to the establishment of a normal capacity level which is often as low as 40% to 50% of theoretical capacity.

Although the normal sales expectancy activity level must be determined in view of physical plant capacity, the more direct approach entails studies of general economic conditions, forecasts of industry volume, and projections of the particular firm's likely share of the market for a series of years. It should be noted that there is potentially some defeating **circularity** involved in the establishing of normal sales expectancy levels. Sales expectancy is necessarily a partial

function of prices charged, and it is possible that these same prices are to be established as partial functions of product cost data based upon sales expectancy.

Many accountants advocate the use of an activity level which represents a **reasonable balance** between plant capacity and sales expectancy. This balance is difficult to determine, and attempts to determine it tend to result in the use of normal production and sales levels rather than of physical plant capacity levels. For example, the Machinery and Allied Products Institute (MAPI Accounting Manual) recommends the following:

> The normal activity level of each cost center should be established at a point which represents a reasonable balance between the probability of selling its output and its capacity to produce. Generally the problem is attacked by determining the practical production capacity of each department or cost center. In doing so, due consideration is given to normal time losses or operating interruptions which arise from machine breakdown, production bottlenecks, absenteeism, vacations, holidays, etc., which make 100% or maximum production unattainable for any protracted period. This practical production capacity is then compared with a computation of direct labor hours required in each department or cost center to produce the sales volume forecasted. Based on this comparison, the normal level of operating activity is established at the number of direct labor hours which will be available to absorb the normal factory expenses.

Expected Actual Volume or Estimated Production. Some cost accountants advocate the use of expected actual volume or estimated production for each period. The end result of such a procedure is similar to that obtained by use of sales expectancy for short time periods. The expected actual volume concept, however, is usually related to periods of a year or less, whereas normal sales expectancy may reflect a series of years.

Blocker and Weltmer (Cost Accounting) suggest that:

> Estimated production, based on the sales expected for the budget period . . . seems the most practical and useful. The present state of the market for the company products, the expected changes in market conditions of a seasonal nature or arising during periods of depression, expected changes in demand due to new styles or to the development of substitute products by competitors, and changing management policies should all be carefully considered in the forecasting of the expected volume of business at prevailing or expected sales prices for the budget period.

EXTENT OF USE OF CONCEPTS OF NORMAL ACTIVITY. A study made by the Research and Technical Service Department of the National Association of Accountants (NAA Bulletin, vol. 19) gives some indication of the relative use of the several different concepts of normal capacity or activity in calculating overhead rates. This study appears to be the most important one made on this subject, and although it was conducted some years ago and was somewhat difficult to tabulate because of some overlapping of methods used, the following tabulation, adapted from the report, is of interest:

1. Companies using estimated production (for one year or less) based only on ability to produce	5
2. Companies using estimated production (for one year or less) based on ability to produce and sell	44
3. Companies using normal capacity based only on ability to produce, i.e., practical capacity	34
4. Companies using normal capacity based on ability to produce and sell over a period of years	89
Total number of companies surveyed	172

In interpreting statistics in this area, it is well to keep in mind the observation made in this NAA research study that the methods of measuring estimated production or normal capacity are not entirely distinct from each other but "one method tends to blend into another. . . . The terms 'normal capacity,' 'estimated production,' 'ability to produce only,' and 'ability to produce and sell' are likely to have different meanings to different people."

ADVANTAGES OF VARIOUS NORMAL ACTIVITY CONCEPTS. Each of the practices of emphasizing physical plant capacity or sales expectancy has certain advantages and disadvantages. The practices of using short periods or long periods for normalizing costs also have their own strong and weak features. Generally the concept used should reflect management's significance rating of various uses to which cost data are to be put and specific interpretations to be made of product cost data.

Schlatter and Schlatter (Cost Accounting) take a position in favor of a **plant capacity concept**, pointing out certain advantages; they state that such a basis for overhead charges:

> . . has the advantage of making, in the accounts and statements, a distinct separation of those costs that result in production from those that do not result in production. It puts a conservative value on the inventories, because the products are charged with only the costs that resulted in goods. As a result the inventories are not inflated with costs incurred in maintaining unused capacity rather than in producing salable goods.
>
> Further, the burden rate based on practical capacity brings out into the open the losses resulting from too low a volume of production. It does not bury these losses by including them in the costs of the goods produced, but shows them separately so that they can get the attention they deserve.

Neuner (Cost Accounting), on the other hand, considers the **practical capacity base** and expresses preference for an **expected activity rate**:

> A more reasonable interpretation of normal operating conditions . . . assumes production at the expected actual volume for a period of a year or less. This may be based upon past performance, adjusted to the present business and economic outlook. The sales budget is usually the determining factor. This method results in a more accurate measurement of managerial efficiency over a shorter period of time.

Advantages of the use of activity levels based on **physical plant capacity** are summarized as follows:

1. Costs of excess and idle facilities are provided to management in the form of unabsorbed charges.
2. Volume variations are subject to reasonable explanation and interpretation.
3. Product costs are not inflated by low sales volume so as to overstate inventories and affect income calculations.
4. Costs are computed upon a relatively fixed and determinable base, with a minimum amount of subjective decision with regard to activity levels. Presumably rates can be set more accurately than is the case with bases involving sales estimates.

Advantages of the use of activity levels based on **sales expectancy**, or what is often referred to as **average capacity**, are as follows:

1. It provides unit cost information which may be readily integrated into an over-all budget or plan for business operation.
2. It results in costs per unit which serve as a guide or basis for pricing decisions.

Randleman (NAA Bulletin, vol. 38) writes:

Average capacity burden rates are suggested for costing burden to production if management has a limited understanding of cost data as used for price setting purposes. However, some uses of cost data cannot be availed of under this approach. Practical capacity burden rates and statistical data to supplement the limitations should be used in costing burden to production if management has been given a clearer understanding of cost information. Only in this way can the advantages of both practical and average capacity burden rates be preserved, to all intents and purposes, and all the purposes for which costs are used, served.

Since cost accounting procedures are generally recognized to be tools for the accomplishment of satisfactory results in many different decision areas, an awareness of the characteristics of results obtained by various methods is more important than the choice of a single concept for use for entry in the accounts. Calculations based upon activity level concepts other than that used for formal record-keeping purposes may provide a valuable supplement to the more formal cost data.

EFFECTS OF NORMAL ACTIVITY CONCEPTS ON UNIT COSTS. The Illinois Manufacturers' Cost Association (Normal Capacity and Its Relation to Costs) illustrates the relative effects of normal activity concepts on unit overhead costs as follows:

NORMAL CAPACITY AND COST

Factory Operating Condition	Monthly Production in Units	Unit Burden
1. Practical capacity	1,000	$2.00
2. Highest sustained rate of production (experienced for one month during year)	900	2.22
3. Average production over several months of regular operation when sales volume was sufficiently uniform to warrant efficient operation	800	2.50
4. Monthly production during a year when most uniform production was maintained throughout the year	700	2.85
5. Average monthly production during previous year	600	3 33

The fluctuation of unit overhead costs in the tabulation here reflects only fixed overhead costs, since they are the only costs relevant to the choice of a normal activity level. If **flexible overhead budgets** are used and a single overhead rate is used for the total of fixed and variable overhead costs, the fluctuation of the overhead rate will not appear so pronounced. The effect upon product unit costs will nevertheless be the same in absolute amount. If variable overhead costs in the preceding example amount to $3 per unit and fixed costs amount to $2 as shown, overhead rates for the various concepts would be as follows:

Monthly Production in Units	Unit Burden
1,000	$5.00
900	5 22
800	5.50
700	5.85
600	6.33

In a similar way the addition of material and labor costs tend to dampen the percentage effects upon total unit costs of product which results from the activity

level concept chosen. No matter what the circumstances are, the unit costs will vary in inverse relationship with the level of activity chosen for use in the determination of charging rates.

UNITS OF MEASUREMENT OF PLANT CAPACITY. Plant capacity and normal activity levels may be measured in terms of units of product, direct machine hours, direct labor hours, direct labor dollars, or total dollar values. Where only one type of product is manufactured, it is convenient to express capacity in **product units**; for example, barrels of flour in a flour mill, tons of rail in a rail mill, pounds of good castings in a foundry, or gallons of pulp from beaters in a paper mill.

In situations where many different types of products are manufactured, a common denominator for all products is needed. For highly mechanized or automated operations, **machine hours** provide this common base. For production that involves mainly manual operations, productive or **direct labor hours** are more appropriate.

Productive or **direct labor cost or total dollar value** are sometimes used to equate products in the measurement of capacity. Such bases have the theoretical weakness of becoming distorted by unpredictable changes in **wage rates** or **selling prices.** If wage rates or selling prices are reasonably stable or if capacity measurements are made at frequent intervals, these latter bases may prove satisfactory.

NORMAL ACTIVITY AND COST CONTROL. The choice of a normal activity level is important to the development of cost data to be used in controlling costs. Control of fixed costs can be accomplished in part by reference to **volume variances.** If departmental foremen or superintendents have some freedom to increase or decrease plant facilities under their control or to change the quantity of goods produced in their department, a **practical capacity level** may best be used. This will provide a needed challenge and a motivating force at the department level. Department heads will attempt to keep volume variances low by scrupulous planning of production and intelligent commitments for fixed costs.

If average or expected activity levels of production are used, volume variances show merely the cost of departing from average or expected production levels. They do not reflect variances from any scientific standard. These variances have limited significance in the control of costs. Needs for volume increases are not emphasized by showing management only the effects of the departure of activity level from a mean level. The practice of using **average activity overhead rates** may in fact encourage management to interpret volume variance information as merely seasonal or cyclical fluctuations which will eventually work themselves out over the long run. Such interpretations may prove damaging.

NORMAL ACTIVITY AND PRODUCT PRICING. If all production overhead costs are charged to products manufactured each month, unit costs will be high in periods of low production and low in periods of high production. It is not feasible to establish a long-term **price policy** based on such widely fluctuating unit costs. Neither is it reasonable to attempt to make short-run price decisions based on such information. The paradox of high unit costs and desired high selling prices when sales are difficult, and low costs and the possibility for price reductions when sales come more easily, may be observed. (The general problem of using cost information for pricing purposes is treated in the section on Special Cost Analyses.)

Long-Term Averages. More useful costs for product pricing involve the spreading of overhead costs over units produced or to be produced over a period long enough to level out short-term fluctuations of production levels. In a statement submitted to the Subcommittee on Profits of the Joint Committee on the Economic Report, Coyle (Profits, Prices, and Products) states:

General Motors' approach to pricing is predicated on a measurement of unit costs calculated on a standard or average volume rate of operations which takes into account plant capacity and the market potential over the long term . . . In approaching the problem of pricing our products, the unit costs thus will not be affected by short-term fluctuations of volume.

The Committee on Research of the National Association of Accountants (Research Series No. 24, NAA Bulletin, vol. 34) reports typical reactions of executives of firms using **average or anticipated activity levels** as follows: "Our standard volume is set by long-range sales probability limited where necessary by capacity of plant, manpower, or materials available. Where equipment in certain centers cannot be used to capacity because of limited need for that type of machine, the cost center burden rate is based on the probable hours of use." This Committee also states in the same report that some companies use costs for price considerations determined by computing overhead rates on "full capacity of the plant to manufacture on a sustained basis" or the "practical capacity to manufacture." Representatives of these companies point out that the practical capacity method "is preferred because costs based upon such a volume had resulted in prices which were competitive in periods of depression and prices which were also profitable when business was good."

Limitations. While recognizing the importance of a **long-run average cost** for pricing products, some writers and businessmen emphasize limitations and pitfalls in the use of certain normal activity concepts and the unit costs which they produce. Thus, Nickerson (Harvard Business Review, vol. 18) comments: "We do not fool ourselves by using an arbitrary normal volume. What we are after is representative actual costs . . . When business is good, the overhead costs based on normal volume are not high enough, and when business is poor they are too high."

In an interview, one company told the NAA Research Committee (NAA Research Series No. 24, NAA Bulletin, vol. 34):

Managements' pricing actions are limited to getting the best price obtainable under current market conditions. Because of the very large capital investment and nature of the industry, operation at high volume must be continuous. The physical bulk of the product makes it impractical to store more than a small portion of the output, and hence sales are made at prices which will keep the products moving. We cannot see how a product cost based on long-period normal volume would be helpful in this company.

The choice of normal activity level to be used in developing unit costs is important for **pricing purposes.** It is even more important to understand the effects of different normal-activity level assumptions upon cost information so that intelligent interpretations may be made of a variety of types of **unit cost figures.**

NORMAL ACTIVITY AND INVENTORY VALUATION. The exclusion of manufacturing overhead from inventories of work in process and finished goods represents an understatement of assets. The Committee on Accounting Procedure of the AICPA (Accounting Research Bulletin No. 43) states:

"As applied to inventories, cost means in principle the sum of the applicable expenditures and charges directly or indirectly incurred in bringing an article to its existing condition and location." Normal overhead costs are generally included in **product inventories.** (A discussion of the direct costing technique and its effects upon inventory valuations will be found in the section on Manufacturing Overhead and Product Cost.)

Monthly or even annual expected activity rates often cause such wide variations of costs per unit due to changes in volume that unit costs are not satisfactory for inventory purposes. Long-term average activity or practical capacity rates are preferred. Schlatter and Schlatter (Cost Accounting) favor the use of a **practical capacity base** and comment on its use for determining inventoriable costs as follows:

> The inventories of goods in process and of finished goods are not inflated by items of cost of unused capacity in the form of idle buildings, machinery, and equipment. It is a distinct advantage to be able to follow good conservative business practice by avoiding inflation of assets on the balance sheet by an amount which is in reality a loss for the period.

Manufacturing Overhead Budgets

MANUFACTURING OVERHEAD AND BUDGETARY CONTROL. An important part of any system of budgetary planning and control involves the planning and reporting of manufacturing overhead costs. Manufacturing overhead cost budgets should be tied in with other cost budgets and revenue forecasts to provide a complete profit plan. In many cases, however, the need for overhead charging rates for costing products and the added difficulties involved in controlling overhead costs have led firms to give special emphasis to budgeting in this area. (Basic concepts of budgeting are treated in the section on Cost Control, Budgets, and Reports.)

Heiser (Budgeting—Principles and Practice) points out that manufacturing overhead costs or factory expenses often total more in the aggregate than either direct labor or direct material costs and are a very important budget item. He indicates, however, that the varied nature of the costs composing factory expenses raises difficult budget-making problems for the following reasons:

> These costs differ from direct costs, first, with respect to their variability with volume of production. Whereas direct costs tend by definition to vary fully with volume, factory expense includes items which are fixed, other items which are fully variable, and still other items which are semivariable. . . .
>
> A second distinctive feature of factory expense is the varied nature of the items with reference to their primary account classifications. Whereas direct material and direct labor refer respectively only to material and labor, factory expense includes items of labor, material, time costs—such as depreciation and taxes, and purchased services. . . .
>
> The factory expense items also differ from direct costs as to the point of incurrence. Direct costs can readily be departmentalized for control purposes. Factory expenses, however, are incurred at many places in the factory, and quite commonly their benefit is so diffused and so far removed from the source that where to control them presents a serious problem.

DEPARTMENTALIZATION. An important prerequisite to effective budgeting and controlling of manufacturing overhead costs is adequate departmentalization. Manufacturing activities should be broken down into producing

and service departments. To the extent that is feasible, separate departments or separate and unmistakable responsibility centers should be set up for each **manufacturing and service function.** In many cases the departmental arrangement established for the costing of products is not sufficient for control budgeting and thus must be modified. The control of costs is effected by individuals rather than by the system of accounting or budgets. It is essential therefore that a department, section, or area of responsibility be established for every foreman or supervisor who has authority to incur or to refuse to incur costs.

ACCOUNT CLASSIFICATIONS. It is fundamental that accounts for accumulating costs must be aligned with the departmental breakdowns used for budgeting. They must be sufficiently complete and detailed to make possible the assignment of each cost item to the responsible department. They must be sufficiently precise to enable those in responsibility to trace causes expeditiously for variations between **actual costs and planned costs.** This latter requirement often involves complete segregations of **prorated or allocated costs from direct departmental costs,** since both the extent and type of control of these two types of costs differ greatly. In most cases it is advisable also to group separately those costs which have like tendencies to change in response to production volume changes. This grouping may simply be a twofold breakdown into **fixed and variable costs,** or it may include additional separate groups for **semi-variable, semi-fixed** (step costs), and **stand-by costs.**

PARTICIPATION OF OPERATING PERSONNEL. Departmental foremen and supervisors must participate in the development of production overhead cost budgets. These are the people who are expected to live within the budget plan and to answer for deviations from the plan. Wholehearted effort and cooperation on the part of these foremen and superintendents is dependent upon their confidence in the plan. There is no better way to instill this confidence than to enlist the services of these operating personnel in the **preparation of budgets.**

In some situations the budget or accounting groups must do the major portion of the work involved in preparing budgets, as well as to take the initiative. In other cases the budget or accounting section may act mainly as a clearing house for the accumulation of departmental budgets, making no more than minor changes in budgeted amounts. In any event it is essential that operating personnel be made to feel that they are working under a **budget plan** which they had an important role in preparing.

FIXED OR STATIC OVERHEAD BUDGETS. Fixed or inflexible budgets for overhead costs are often used to provide a coordinated plan of spending. Such budgets sometimes take the form of **appropriation budgets,** which are common in budgeting for nonprofit organizations. **Forecast budgets** which are common in business budgeting also may be classified as fixed budgets, since they do not automatically provide for adjustment to actual operating levels. Budgets of this type represent a forecast or plan prepared in advance which provides fixed amounts against which actual results are to be measured.

The overhead budget should be integrated into an **over-all budget plan,** but this is difficult when a fixed budget is used for overhead.

Welsch (Budgeting: Profit-Planning and Control) points out:

> Under the fixed budget procedures for expenses, the analysis of expenses and determination of expense allowances for budgetary purposes cannot be undertaken until the sales and production budgets are completed. Thus the analysis of expenses neces-

sarily becomes a step in planning budget preparation that must be accomplished in an inflexible sequence.

Only if **volume forecasts** are unusually accurate, or if there is virtually no basis for advance establishing of **cost behavior patterns** in response to production volume, can fixed budgets be justified for cost control purposes. These conditions are rarely found. The fluctuation of costs in reaction to production volume deviations from plan will generally distort comparisons of actual and budgeted costs so much as to make variance information useless if not actually misleading. The more general practice is to establish budgeted amounts for overhead costs which are conditioned by an assumed activity level and to provide a means of flexing these **bench-mark figures** to relate to actual production volume. Only in this way can variances of variable overhead costs be made meaningful for cost control purposes.

FLEXIBLE OVERHEAD BUDGETS. Flexible overhead budgets used for cost control are of two types, distinguished by the manner in which they are given flexibility. If flexibility is provided by classifications of fixed and variable groupings, the budget is often referred to as a **tabular budget.** Only one or possibly two columns of amounts for each department is required. This type of budget is illustrated subsequently in this section in Fig. 2. If classifications by variable or nonvariable tendencies are not used for providing flexibility, the budget will usually be presented in a **columnar budget.** Different amounts are budgeted for each of several different levels of possible production activity. This type of budget is illustrated subsequently in this section in Fig. 3.

Selecting an Activity Base. Flexible budgets are based on the assumption that many costs fluctuate in response to volume of production or the rate of operations. The **base unit** used to measure this volume or rate is therefore of primary importance. In choosing this base unit, the objective should be to determine the factor with which overhead costs are most closely correlated. (See "Classification of Overhead According to Variability" in section on Accumulation of Manufacturing Overhead.)

The most appropriate base unit of measure should not be expected to be the same for all companies in an industry or necessarily for all departments in a given plant. Units of product, direct labor costs, direct labor hours, machine hours, or standard labor cost or hours may serve as the base unit of measure for **producing departments.** For **service departments,** units of measurement especially applicable to the specific service provided may be used; for example, kilowatt hours of power for a power plant, number of employees of departments served for a timekeeping or payroll function, or labor and/or machine hours for a repair and maintenance department. In some cases, however, it is necessary to measure activities of service departments in terms of the combined activities of producing departments.

In expressing activity levels for control budgeting, it is common to make use of **potential operating capacity** as the 100 percent activity level and to state actual levels as a portion of this **capacity.** Thus, in a department with ten machines operating on a 40-hour week, the maximum capacity is 400 machine hours. Assuming a 20 percent allowance for various influences which make the attainment of maximum capacity impossible, the potential or practical operating capacity is 320 machine hours. Using this as 100 percent, other rates of operation can be stated either in terms of machine hours or in percentages of potential operating capacity of 320 hours. Thus 208 machine hours would be expressed as 65 percent of capacity.

Overhead Cost Behavior. No matter what method is used to give flexibility to overhead budgets, it is important that studies be made of cost behaviors in relation to the base measuring unit. This is essential to effective **analysis of historical costs, cost control,** and **cost and profit planning.** For cost control, and especially for profit planning, the costs of the future are of prime significance. In many cases these costs are developed by accounting and budgeting personnel with the assistance of engineers, economists, and operating foremen and superintendents. All factors destined to affect **future costs** that are known to this broad group of individuals should be incorporated into overhead budgets without regard to historical costs. An analysis of **historical cost behavior,** nevertheless, provides important clues to costs of the future and thus to proper budget figures

The Committee on Research of the National Association of Accountants (NAA Research Series No. 16, NAA Bulletin, vol. 30) distinguishes three general approaches to the measurement of **cost variation with volume,** as follows:

1. Inspection of the company's chart of accounts and assignment of costs to fixed or variable categories according to the type of cost represented by each account.
2. Statistical analysis of previously recorded costs to determine how costs have varied with volume.
3. Industrial engineering studies to determine how costs should vary with volume.

The Committee notes that each of these methods has its own field of usefulness for the purpose and also its limitations. In actual practice it is usual to find all three methods used together.

It is usually possible by inspection of the overhead accounts to determine certain items to be **fixed** or unresponsive to changes in the activity level either by actual nature or by accounting practice. Examples of such items might include depreciation calculated on a straight-line time basis, insurance and taxes on building and machinery, and departmental supervision. Other overhead costs such as production supplies, small tools, and power consumed by production machinery may fall naturally into the **variable** cost category, since they are directly responsive to production activity. It is nearly inevitable that behavior of some overhead cost items will reflect both fixed and variable tendencies. Indirect labor and maintenance provide examples of such costs. These are usually classified as **semi-variable.** Such items should be studied individually to ascertain the nature of their behavior. The study of behavior patterns of semi-variable costs usually takes the form of reference to past experience and industrial engineering investigations.

Correlation of Overhead Costs with Volume. Studies of past records to determine the correlation of semi-variable overhead costs with volume are often made.

Nickerson (Cost Accounting) points out:

Practice varies as to the number of years of cost history selected for study. Five years is a common figure, though many companies have made studies of cost relationships for periods of ten, fifteen, and even twenty years. The purpose has been, primarily, to establish what might be regarded as typical or representative relationships over a period of time. For such a purpose it is often desirable to adjust historical figures by eliminating every unusual or nonrepetitive item of expense. Sometimes it is even desirable to eliminate the figures for an entire year if the costs for that year are considered to be quite abnormal. This does not mean, of course, that abnormalities are not to be expected in the future; however, if a reliable basis of normal experience can be established, it can be adjusted to allow for expected

abnormalities in a particular future period or for abnormalities that have occurred during a period.

It must be granted that there are times when conditions have so changed that the cost experience of previous years is markedly unsuitable as a guide in establishing cost standards for current or future operations. Under such conditions, it may be best to restrict the study of costs to a study by months of the experience for the most recent twelve months or to deal only with projections of future expectations with respect to costs.

The **scattergraph** and **least-squares** methods of determining the fixed and variable portions of cost are described and illustrated in the section on Accumulation of Manufacturing Overhead.

Tabular Budget. After all semi-variable overhead costs have been studied and their fixed and variable elements determined, these costs may be put together with strictly fixed and strictly variable overhead cost items to provide a flexible overhead budget. The data are often arrayed in a tabular form as illustrated by Matz–Curry–Frank (Cost Accounting) in Fig. 2.

BUDGET ALLOWANCES FOR MACHINING DEPARTMENT

Activity Base: Normal capacity, 4,000 direct labor hours per month = 80 percent rated capacity.

Acct. No.	Account Title	Fixed Expense	Variable Rate per Direct Labor Hour
01	Indirect Labor	$ 600	$ .075
02	Clerical Help	120	.01
10	Setup Men	800	.07
14	Rework Operations	100	
28	Supervision	1,200	
41	Factory Supplies	200	.025
	Total expenses controllable by department head	$3,020	.18
55	Insurance—Fire, etc.	80	
57	Taxes—State and Local	40	
63	Depreciation	500	
	Total noncontrollable	$ 620	
71	Maintenance	$ 600	.20
74	Building Occupancy	780	.02
77	Gas, Water, Steam, and Air	540	.21
79	General Expenses	450	.05
	Total Service Dept. (apportioned)	$2,370	.48
	Total	$6,010	$ .66

Fig. 2. Tabular forms of overhead budget.

Budgeted amounts for any overhead item or for total overhead cost for any level of operation may be determined from the budget figures shown in Fig. 2. If, for example, during the month of May the department operates 4,200 direct

labor hours, total budgeted overhead costs amount to $6,010 plus 4,200 hours at $.66 per hour, or $8,782.

The fixed and variable grouping of overhead costs for budget purposes, as shown in Fig. 2, provides a straight-line cost function which lends itself well to cost analysis. A clear understanding of limitations of this **straight-line analysis** is important. Wyer (*NAA Bulletin*, vol. 38) points out that:

> Contrary to popular control concepts, the cost incurred at any given level of activity will differ according to which way volume is trending . . . If volume is increasing, costs will be incurred at any given level, the counterpart of which should not be incurred when the same level is reached on the downward spread . . . To attempt to use for retrenchment the same flexible budget which you prepared during period of expansion will result in waste.

Fixed and variable cost classifications provide a practical approach to flexible budgeting. It is nevertheless true, as stated by Vatter (NAA Bulletin, vol. 35) that "to make judgment . . . it is necessary to know something more about cost behavior than the simple dichotomy of variable and fixed costs." (For further discussion, see "Limitations of Usefulness of Variable and Fixed Costs" in the section on Accumulation of Manufacturing Overhead.)

Columnar Budget. In some situations many semi-variable overhead costs tend to change in an **irregular pattern,** thus showing wide deviations from a straight line or perhaps appearing to follow a **curved line.** In such cases the use of a columnar budget or a series of overhead budgets may be preferred.

DEPARTMENT RX — MONTH OF MARCH, 19__

Overhead Costs	Production (Normal Capacity = 20,000 Hours = 100%)				
	80%	90%	100%	110%	120%
Fixed:					
Foreman	$ 300	$ 300	$ 300	$ 300	$ 300
Space charge	800	800	800	800	800
Machinery depreciation	200	200	200	200	200
	$1,300	$1,300	$1,300	$1,300	$1,300
Semi-variable:					
Indirect labor	$ 600	$ 650	$ 690	$ 760	$ 840
Assistant foreman	...	...	...	150	150
Royalties	400	480	550	630	700
Repairs and upkeep	300	310	320	350	380
Clerical salaries	200	200	240	240	280
	$1,500	$1,640	$1,800	$2,130	$2,350
Variable:					
Supplies	$ 240	$ 270	$ 300	$ 330	$ 360
Wastage	50	60	60	70	100
Power	490	540	600	660	730
	$ 780	$ 870	$ 960	$1,060	$1,190
Total overhead cost	$3,580	$3,810	$4,060	$4,490	$4,840

Fig. 3. Columnar form of overhead budget.

A columnar form of an overhead budget is adapted from Devine (Cost Accounting and Analysis) in Fig. 3. Here it will be noted that semi-variable cost items and some variable costs change at irregular rates. Royalties, for example, increase $80 for a change of 2,000 hours from 16,000 to 18,000; $70 for the same change from 18,000 to 20,000 hours; and $80 again for a change from 20,000 to 22,000 hours. By this sort of technique, overhead cost items may be budgeted in view of the best information available without the restriction of assuming a straight-line pattern.

To determine budgeted overhead cost by using a flexible columnar budget such as Fig. 3, **interpolation** is usually necessary between budgeted activity levels. If, for example, operations in March are at 19,600 hours, budgeted overhead cost amounts to $4,010. This figure is based on an assumption of a **straight-line pattern** of cost between 18,000 and 20,000 hours, but it assumes nothing with regard to the pattern of cost behavior outside of this narrow range. Since budgeted costs increase from $3,810 to $4,060, or by $250, for an increase of activity from 18,000 to 20,000 hours, the rate of change is found to be $250 divided by 2,000 hours, or 12½¢ per hour. Since 19,600 hours is 1,600 hours in excess of 18,000 hours, the overhead cost budgeted for 19,600 hours is that budgeted for 18,000 hours, or $3,810 plus (1,600 hours at 12½¢, or $200), or $4,010.

Fig. 4, adapted from McAnly (NAA Bulletin, vol. 39), shows the relationship between flexible budgeting and the development of an overhead rate for a depart-

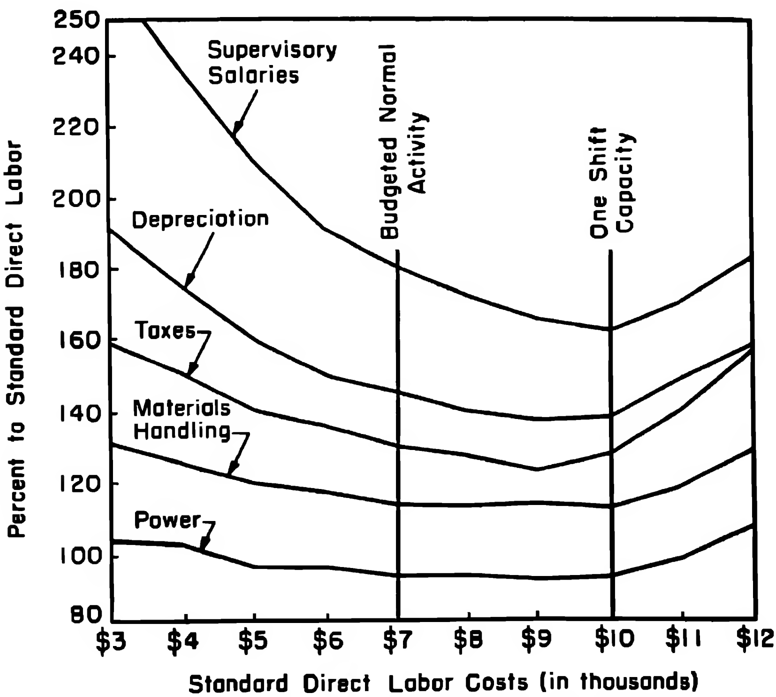


Fig. 4. Normal overhead rates showing effect of volume.

ment. The effects of volume upon the rate may be noted. As McAnly points out: "The normal capacity point represents a reasonable average operating condition which is contemplated. The burden rate should reflect this normal operation. It should be set up so as to be adjustable to conform to any set of operating conditions."

OVERHEAD STANDARDS. Flexible budgets for overhead costs as used in business usually represent estimates of what costs will be. They are in most cases conditioned strongly by historical costs. Overhead costs do not lend themselves readily to the development of standards in the engineering sense. Nevertheless the use of **overhead budget variance** information for control suggests the concept of standard overhead costs.

Brummet (Overhead Costing) suggests:

A point which has not been recognized to any great extent in practice is the need for engineered overhead efficiency standards to replace bench marks which are based solely on historical records of overhead costs. Just as in the case of material and labor costs, management should know the deviation of actual overhead costs from what they should have been, rather than the deviation from what they actually have been in the past. A knowledge of what overhead costs of the past have been should be only a partial guide for determining what they should be in the future.

This same point is made by Wyer (NAA Bulletin, vol. 38):

Clearly, accurate determination of how a cost should vary with volume is an engineering task rather than a matter of accounting The fact that adequate control bases cannot always readily be found for indirect costs does not force the conclusion that they can be controlled only through past experience by a generalized, inaccurate control base. They, too, can be engineered.

Normal Overhead Rates

GENERAL FORMULA. The generalized formula for computing a normal rate is

$$\frac{\text{Budgeted overhead at normal activity level}}{\text{Normal activity level}} = \text{normal rate}$$

The uses of rates so determined implement the **theory of normal burden** stated by Schlatter and Schlatter (Cost Accounting):

The burden attributable to a unit of product is an amount equal to the amount of budgeted burden per unit of activity at normal capacity, multiplied by the number of units of activity required to produce a unit of product. . . . The amount of burden attributable to a unit of product is not affected by the volume of actual or expected activity. If, at a normal volume of 10,000 direct labor hours, budgeted burden is \$20,000, each unit of product is chargeable with burden of \$2 multiplied by the number of direct labor hours required to produce one unit of product, regardless of the actual or expected activity. In a period in which activity is 1,000 direct labor hours and budgeted burden is \$11,000, the burden attributable to a unit of product is the number of direct labor hours required to produce one unit multiplied by \$2, not by \$11.

In determining the normal rate, activity level may be stated in terms of units of product, labor dollars or hours, or machine hours. Rates may be used for each department or cost center, or they may be applied as **blanket or plant-wide rates.**

The term "normal" is often used loosely, so that clarification of meaning of the term is necessary for satisfactory communication in each instance. The most

essential and usual connotation of "normal" is that it represents **a long-term measurement.** It may represent an average of the estimates for several years, or it may be a measurement of practical capacity for a period of at least one year. The use of "normals" always should serve to level out **seasonal** and sometimes **cyclical fluctuations** of activity when allocating unit charges to products.

OVERHEAD ABSORPTION, USING PRACTICAL CAPACITY RATES. Fig. 5, adapted from Schlatter and Schlatter (Cost Accounting), shows graphically the amount of overhead applied to the product at varying rates of activity. The horizontal axis *SP* represents **activity,** with normal activity based

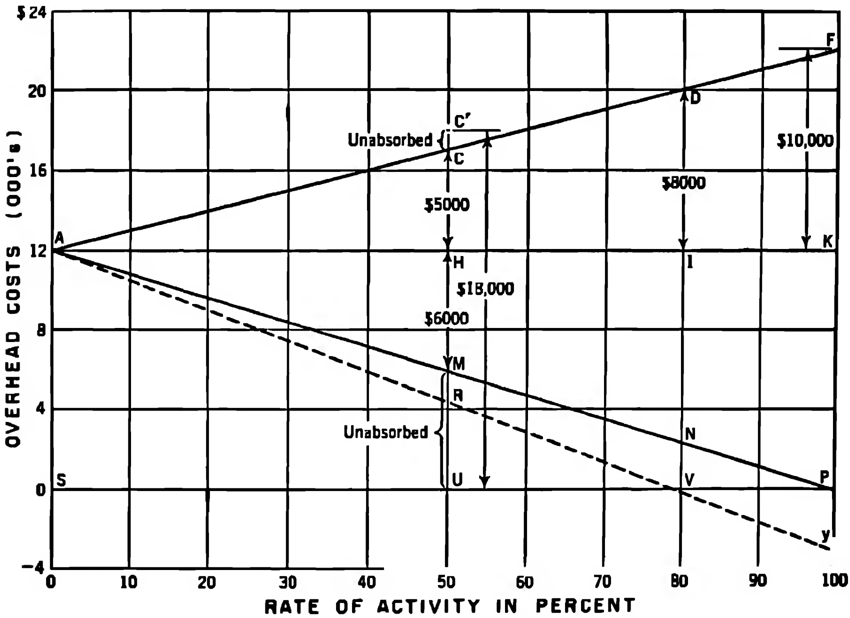


Fig. 5. Graph of overhead absorption.

on practical operating level, at *P* (100%). The vertical axis *PF* represents **overhead costs** in dollars. The line *AK* marks the division between **fixed and variable costs.** Hence, any vertical line drawn from *SP* to *AK* shows the amount of fixed costs; for example, the line *VI*.

The line *AF* represents **budgeted variable costs** at varying rates of activity. Thus, at *A* (zero % activity), there are no variable costs, and at *F* (100% activity) the variable costs amount to $10,000. At any rate of activity, a vertical line erected from the line *AK* to the line *AF* gives budgeted variable costs (line *ID* shows $8,000 variable expense at 80% activity). Note that these vertical lines vary proportionately to the rate of activity, i.e., line *ID* is 80% of line *KF*, which gives the variable cost at 100% activity.

If **burden absorption rates** are computed on the basis of practical capacity ($22,000 total overhead cost divided by production as measured at practical capacity), the lines drawn vertical to axis *SP* and extending between the lines

AP and *AF* represent the amount of overhead applied to the product at any rate of activity. Thus, the line *MC*, at 50% of practical capacity, shows *MH* ($6,000) of fixed cost absorbed and *HC* ($5,000) of variable cost absorbed. Assuming that actual overhead for a given period was $18,000 (line *UC′*), when activity was at 50% of capacity, there is unabsorbed burden represented by *CC′* ($1,000) and *UM* ($6,000). The line *CC′* gives the amount by which actual overhead cost exceeded the budgeted amount; and the line *UM* gives the amount of fixed cost which is unabsorbed due to below normal activity.

In general the line *AP* constitutes the dividing line between fixed costs that are absorbed by the normal burden rate and fixed costs that are unabsorbed and therefore charged off to the profit and loss account.

OVERHEAD ABSORPTION, USING NORMAL SALES EXPECTANCY RATES. If normal capacity based on sales expectancy is to be used as a base for calculating a normal burden rate, the amount of fixed overhead applied to the product at varying rates of activity is represented by the line *AY* (Fig. 5). This assumes that the sales expectancy rate of operations for the specified period is 80% of practical capacity. (In this case the normal burden rate is obtained by dividing $20,000, the total overhead cost represented by the distance *VD*, by the production as measured at the 80% level.)

The total amount of overhead applied to product is represented by lines drawn vertical to the axis *SP* and extending between the lines *AY* and *AF*. Thus, the line *RC* (at the point of 50 percent of practical capacity) shows *RH* ($7,500) of fixed cost absorbed and *HC* ($5,000) of variable cost absorbed. Two points are significant:

1. If a flexible budget is used, the same amount of variable cost is absorbed, no matter which base is used for determining the normal (for example, line *HC* at 50 percent activity).
2. Hence the comparative effect of the two bases (practical operation vs. sales expectancy) is felt in the amount of fixed cost absorbed. When activity based on practical operating level is used, the fixed cost absorbed amounts to *MH*; when activity based on sales expectancy is used, *RH*.

In general, the vertical distance between the lines *AP* and *AY* shows the difference between the two bases from the viewpoint of the application of fixed cost to the product. Point *P* represents the practical capacity of the department or plant; however, if burden rates are set on the basis of point *V* (sales expectancy equals 80% activity, due to inadequate demand for product), they have the effect of applying to the product some of the fixed cost of unused facilities

USE OF SEPARATE RATES FOR FIXED AND VARIABLE OVERHEAD. The distinction between fixed and variable overhead costs is often carried into rate determination. To develop separate rates, fixed and variable overhead costs must be segregated in the budgets of both service and producing departments. The fixed costs of service departments should be distributed to producing departments on a basis of **relative capacity**, and variable overhead costs should be distributed on a basis of **consumption**. In this way, fixed service department costs remain fixed for producing departments, while the variable service department costs remain variable for producing departments.

Blocker and Weltmer (Cost Accounting) state:

Instead of having a single standard overhead application rate for each production department, or for the concern as a whole if no departmentalization exists, it is possible to have two standard rates for each department. One rate is for the allocation

of fixed costs; the other is for purposes of distributing the variable costs to production. Thus, for Department A, the following two formulas may be used:

$$\frac{\text{Standard fixed overhead for Dept. A for budget period}}{\text{Standard direct labor hours for Dept. A for budget period}} = \text{standard rate for fixed costs for Dept. A}$$

$$\frac{\text{Standard variable overhead for Dept. A for budget period}}{\text{Standard direct labor-hours for Dept. A for budget period}} = \text{standard rate for variable costs for Dept. A}$$

The fixed standard rate plus the variable standard rate gives for the budget period the total standard overhead rate which is to be used in computing standard unit costs and in absorbing overhead as a manufacturing cost. Each foreman, supervisor, and department head should be informed of the standard rates for variable costs applied to production under his jurisdiction, and he should be given monthly reports to show how closely the actual variable overhead costs for his division conform with the standard variable overhead costs.

Advantages of Separate Rates. There are certain advantages in the use of separate rates for fixed and variable overhead costs:

1. **Differential costs** are more readily determinable.
2. Division between fixed and variable cost is carried forward into all **unit cost computations,** which is of advantage to the sales division in making bids, particularly where volume considerations are involved.
3. It aids in making cost adjustments from year to year. The **variable cost rate** is constant no matter what the rate of activity. Once these rates have become set, after a year or two of experience, they may take on the character of a **basic standard** and will not be subject to change until or unless some major change in technology or organization occurs.
4. Double rates permit easy shifting of unit costs from a standard basis to a current budget basis. Variable unit costs are the same for any level of activity; it is fixed burden which is affected by fluctuations in volume. If all **departmental normals** are set at the same point relative to maximum capacity, one computation for total fixed overhead cost applied suffices to convert the standard unit cost for fixed overhead to any budget basis. The addition of variable costs per unit yields recomputed unit costs on the new budget basis.
5. Where two overhead rates, one for fixed and one for variable costs, are available, costs computed at **practical capacity** may be used for internal costing entries and for cost inventories, while these same costs may be modified to the level of the **current budget** for sales and pricing policy purposes.
6. Determination and use of fixed and variable rates for overhead is an integral part of **departmental budgetary control** procedure. Each day the foreman has an accurate knowledge of his direct labor costs, direct labor hours, or machine hours. This total, multiplied by his variable rate for overhead, gives him information regarding what his variable costs should have been. **Daily cost control reports** may be issued on this basis.

Standard Overhead Rates

GENERAL FORMULA. The generalized formula for computing a standard overhead rate is

$$\frac{\text{Standard overhead cost at standard activity level}}{\text{Standard activity level}} = \text{standard rate}$$

This formula differs from that used earlier in this section for a normal overhead rate only in the replacement of the words "budgeted" and "normal" with the

word "standard." This distinction is often slight, but it is significant. (See section on Setting Standard Costs for a detailed discussion of that subject.)

STANDARD AND NORMAL OVERHEAD RATES. The terms "normal overhead rate" and "standard overhead rate" are used loosely, often interchangeably. In some instances the "normal rate" is established as a standard rate, but such is not always the case. To normalize is not necessarily the same as to make standard. While standard overhead rates tend to normalize charges to products, their essential characteristic is that they are the result of standard costs and standard activity levels rather than possibly only **past period averages, estimates,** or **"bogey" budgets** of costs and activity. They are based upon desired goals, objectives, or levels of performance. This involves establishment of desired activity level and cost objectives for various activity levels.

Nickerson (Cost Accounting), after discussing normal burden rates, states:

Although the same types of burden rate are developed under standard costing, they are often on a sounder basis, because the introduction of standard costing is typically one aspect of a general drive toward better management and lower costs, and greater thought and effort have therefore been applied to the development of the rates.

The distinction between normal, nonstandard, overhead rates and standard overhead rates is basically the same as the **distinction between budgets and standards.** Henrici (Standard Costs for Manufacturing) points out that budgets are used for comparisons to be sure that actual costs are not exceeding expectations and that standards, on the other hand, do not necessarily show what costs may be expected to be but rather what they could be if certain highly desirable performances were attained. In a healthy business, costs do not exceed budget; they do approach standard.

Current increased concern for overhead costs and the **engineering of overhead standards** emphasizes the differences between normal rates and standard rates. The determination of a standard overhead rate involves establishing a **standard activity level** and **standard overhead costs.** The measurements of these two components of a standard rate are somewhat interrelated. The activity-level base determination is usually decided upon first, since standard quantity and price factors are directly dependent upon this measurement.

STANDARD ACTIVITY LEVEL. Concepts used for standard activity levels range from that produced by a measurement of one-, two-, or three-shift uninterrupted production to **short-term expected production.** The concept used should reflect, in general, management's desire for **full cost absorption** as opposed to **partial cost absorption** accompanied by volume variance measurements. The use of theoretical or practical capacity as standard is equivalent to the use of an "ideal" or "tight" standard. The use of long-term (a series of years) average activity represents a normalization technique with no effort to provide significant volume variance information. To use short-term (a year or less) expected activity may serve to normalize **monthly** or **seasonal fluctuations,** but no significant **volume variance** information is produced.

If standard costs for production overhead are to be standard in the "good performance" sense usually applied to material and labor costs, the activity levels used should mainly reflect physical production capacity. Only in this way is complete standard cost variance information provided, and only in this way is management kept informed of **idleness costs** as a regular function of the accounting system.

Use for Cost Control and Inventory Costing. A conflict sometimes arises in the use of rates based upon the same standard activity levels for both cost control and for inventory costing. The Committee on Research of the National Association of Accountants (Research Series No. 11, NAA Bulletin, vol. 29) minimizes this possible conflict as follows:

With respect to overhead the control standards are found in the flexible budget, while the inventory costing standard is the normal overhead rate, since cost control requires controllable cost at actual volume of activity, and inventory costing calls for total overhead at normal capacity volume. However, these are related if the normal rate is derived by dividing the units of production at normal into the total overhead budgeted for this level of activity . . . With the same set of standard costs acceptable for both of these purposes, cost control reports can be drawn directly from the books and the same standard costs can be used for inventory costing.

The concept of **normal** used in this quotation involves mainly a normalization of costs. If a full-capacity concept of standard activity level is used, it may be appropriate to make special adjustments in the costing of inventories.

Standard or Normal Volume. Kohler (A Dictionary for Accountants) comments on the problem of establishing the standard or normal volume as follows:

Establishment of the volume denominator in the rate at which manufacturing overhead is applied to products has occasioned much discussion in accounting literature. However, there now seems to be general agreement that the following factors need to be considered:

1. Practical capacity of the plant to produce on a sustained basis. Allowance for delays, downtime for repairs, and similar causes of nonproduction is made to the extent that they are unavoidable.
2. Quantity of product that can be sold. Where production capacity exceeds the amount that can be sold in some periods, the objective is to choose a volume figure which levels the swings in sales volume over a seasonal or cyclical period.

Revision of standard volume needs to be made for changes in production capacity, long-term trends in sales, and any other conditions which have a sustained effect on production and sales. In practice, most companies review their standard volume annually at the time the budget is prepared for the ensuing year.

The **normal capacity** used to determine overhead cost content of standard product costs is discussed in the Uniform Accounting Manual for the Electrical Manufacturing Industry (National Electrical Manufacturers Association) as follows:

To determine normal capacity, each group of like machines, bench positions, or assembly operations designated as a cost center should be separately listed and multiplied by the number of annual working hours to ascertain the maximum man or machine hours available with respect to each. Ordinarily, this maximum should be based upon single-shift, no-overtime operations unless multi-shift or overtime operations are inherent in the nature of the manufacturing process or constitute established practice in the branch of the industry concerned. Normal time losses, as disclosed by an analysis of past experience, should then be computed for such items as vacations, holidays, absences, idle time, machine downtime, etc. These estimated losses are deducted from maximum available capacity, to establish a practical operating level.

A normal sales forecast should then be established, based upon the average annual sales for a selected period as adjusted by probable future sales trends and market conditions. The base period will usually range from two to five years, in order to ensure that the Indirect Manufacturing Expense Rates established will not be dis-

torted by unusually high or low levels of activity within a single year's operations. This forecast should list sales by product lines and where possible by individual products. Each listed item should then be converted into a quantitative measure of the capacity required to make it, segregated according to departments or productive cost centers where the work will be performed.

When the requirements indicated by the sales forecast have been established, according to the Uniform Accounting Manual (NEMA), the available practical capacity of each cost center should be compared with the requirements and the lesser of the capacity to make and the capacity to sell should then be adjusted for the following conditions:

1. Even though manufacturing capacity as a whole may be greater than selling capacity, certain productive operations may not be available in the required capacity to manufacture products listed in the sales program. In any event, the projected sales program should be reduced to the extent indicated, and corresponding reduction made in the required productive capacity of other departments or cost centers performing related operations on the products affected.
2. Conversely, while selling capacity as a whole may exceed the ability to produce, this will not necessarily be true for all products. The practical capacity of operations relating to products sold in limited quantities should therefore be reduced to an appropriate level.
3. In any case, when the available practical capacity of certain machines or departments is disproportionate to that of preceding or subsequent operations, the capacity of all equipment performing related operations should be reduced to the level of the limiting equipment unless it can be supplemented by subcontracting.

After these adjustments have been completed, the result is a compilation of net balanced practical capacity by cost centers or operations (expressed in such terms as man hours, machine hours, or labor dollars). This then serves as an appropriate basis for the establishment of indirect manufacturing expense rates.

STANDARD OVERHEAD COSTS. A variety of procedures and concepts are reflected in practices with regard to the setting of standard overhead costs. (Overhead budgets are discussed under Manufacturing Overhead Budgets in this section.) Gillespie (Cost Accounting and Control) states:

> There are several methods of setting standards for factory expense, that is, of deciding how much the supervisor should be allowed per standard direct labor hour or other factor for measuring volume. They vary in simplicity and scientific accuracy. The allowances may be based upon intelligent guesses, or analysis of past actual expenses in relationship to volume, or industrial engineering studies of the same kind as the time and material standards . . .

Certain items of overhead such as indirect labor, power, supplies, and small tools may be studied and "engineered" in terms of both **quantity** and **price factors** in a manner similar to that used for raw materials and direct labor costs. Other items such as depreciation, insurance, taxes, and certain allocated costs of other departments do not lend themselves to such studies. In these cases the budget or standard costs are usually based upon historical costs, with adjustments for current plans which make costs of past periods inappropriate.

Keeping the cost control objective foremost, management should insist upon continuous objective study to determine what overhead costs should be and should build the results of such study into **overhead cost standards.** If this function is satisfactorily accomplished, overhead cost variance information will prove highly useful.

Under- or Overabsorbed Overhead Balances

NORMAL AND ACTUAL COST DIFFERENCES. When normal or standard overhead rates are used to assign overhead costs to products, it is usual for a difference to exist between the actual overhead costs incurred and the normal or standard overhead costs absorbed. If the actual costs exceed the absorbed or applied costs, excess debits remain in departmental overhead accounts, and overhead is said to be **underabsorbed.** If actual costs are less than the absorbed or applied costs, excess credits remain in departmental overhead accounts, and overhead is said to be **overabsorbed.** These under- or overabsorbed balances present problems of analysis for management control purposes, as well as the problems of disposition within the accounts and in the presentation of financial reports.

ANALYSIS OF UNDER- OR OVERABSORBED BALANCES. A study of the Committee on Research of the National Association of Accountants (Research Series No. 13, NAA Bulletin, vol. 29) shows that while there are three factors which can cause overhead variances (namely, production volume, production time, and spending), only the **total overhead variance** is developed on the books. Companies do not make a distinction, generally, between the different overhead variances in variance disposal. The analysis of overhead variances for cost control or other purposes is done off the books

Analysis of under- or overabsorbed overhead balances often takes the form of an **overhead cost variance report** such as that in Fig. 6. This report shows (1) **budget** variance, the detail of the deviation of actual overhead costs from budgeted amounts, (2) **volume** variance, a calculation of the variance caused by deviation of the actual activity level from the normal or standard level, and (3) **efficiency** variance, a calculation of a variance caused by activity in excess of that required at standard efficiency. Only the first two of these three variances can be determined if overhead rates are applied to actual labor hours rather than to standard hours produced. The use of standard hours produced is possible only if standards are used for the activity measure—in this situation for direct labor hours. (For a more detailed consideration of overhead cost variance, see the section on Analysis and Control of Standard Cost Variances.)

DISPOSITION OF OVERHEAD BALANCES. The problem of disposing of overhead balances in the accounts is basically one of financial accounting, since it involves **inventory valuations** and **income measurement.** The problem should not be confused with that of variance interpretation and presentation for management control of costs. No matter what procedure is used for dealing with under- or overabsorbed overhead balances in the accounts or on financial statements, the cost accountant should make certain that significant overhead variance figures are brought to the attention of responsible management personnel.

A variety of practices exists regarding the disposition of under- and overabsorbed overhead caused by the use of normal or standard overhead rates. With reference to the use of **normal rates,** Neuner (Cost Accounting) points out that if under- or overabsorbed amounts are computed monthly, the overapplied overhead of one month may be offset by the underapplied in the following month, and vice versa.

Therefore, according to Neuner, many concerns carry forward the over- or underapplied manufacturing overhead, from month to month, handling it as deferred income if overapplied and as a deferred charge if underapplied. The

DEPARTMENT C

BUDGET AND VARIANCE REPORT

MONTH OF MAY, 19__

Actual direct labor hours	2,070	Overhead rate, fixed costs	$ .50
Normal direct labor hours	2,400	Overhead rate, variable costs	$ .75
Standard hours produced	2,000		

	Budget for 2,070 Hr.	Actual Overhead	Variances from Budget (Excess Actuals)
Fixed:			
Insurance	$ 60.00	$ 60.00	$ -0-
Taxes	90.00	90.00	-0-
Depreciation	250 00	254.00	(4.00)
Supervision	800 00	600.00	-0-
Totals	$1,200.00	$1,204.00	($4.00)
Variable:			
Indirect Labor	$ 621.00	$ 684.50	($ 63.50)
Supplies	207.00	203.00	4.00
Repair and Maintenance	310 50	316.00	(5.50)
Power	414.00	480 00	(66.00)
Totals	$1,552 50	$1,683 50	($131.00)
Grand Totals	$2,752.50	$2,887.50	($135 00)

Actual overhead costs (as above)	$2,887.50
Overhead costs applied (2,000 hr. @ $1.25)	2,500.00
Overhead Underabsorbed	$ 387 50
Budget variance (unfavorable, as above)	$ 135.00
Volume variance (unfavorable) $2,752.50 — $2,587 50, or 330 hr. @ .50	165.00
Efficiency variance (unfavorable) $2,587.50 — $2,500, or 70 hr. @ $1.25	87.50
Overhead Underabsorbed (as above)	$ 387 50

Fig. 6. Overhead cost variance report.

amount of the over- or underapplied overhead is closed into the Cost of Goods Sold account at the end of the fiscal period. Since some of the production for the period to which the over- or underapplied overhead should have been allocated may still be in the work-in-process or finished goods inventories, this is not altogether correct theoretically. This amount is presumed not to be disproportionately large, however, and therefore most accountants use the simpler and more practical method of closing this amount into the Cost of Goods Sold account.

Overhead Variances as Period Costs. If overhead cost variances are treated as period costs, they are either closed to cost of sales or to the revenue and expense summary. In line with the first alternative, the amounts are shown as a deduction or an addition to cost of sales on the income statement. If the latter

alternative is used, the amounts may be shown on the income statement as separate deductions or additions to gross profit or as other expense or income.

Overhead Variances as Product Costs. If it is management's desire to treat overhead variances as product costs, it is necessary to adjust work-in-process and finished goods inventories and costs of sales. The essence of the procedure is to make adjustments so that inventory and cost of sales accounts will reflect the balances that would have been produced had actual rather than normal or standard overhead costs been absorbed. This is usually accomplished by use of **supplementary overhead rates.** (This procedure related to standard costs is illustrated in the section on Operation of Standard Costs.)

Overhead Variances Transferred to Suspense Account. This practice is customarily used for monthly closings. It produces debit or credit balances held in suspense which are reflected on balance sheets. If applied to annual closings, the procedure would involve the offsetting of underabsorbed overhead in one year with overabsorbed overhead in another year. The idea is to extend to an entire business cycle the principle applied to monthly variations in a seasonal business. It constitutes a logical disposition of **volume variances** which arise when a normal rate has been established on the basis of customer demand over a period of years in the future, particularly if the number of years chosen on which to base sales expectancy coincides with the span of the business cycle for the specific industry.

A slight variation of the use of the suspense classification of overhead variances is the practice of crediting overabsorbed overhead to a suspense account; against this, underabsorbed overhead is charged until the balance is exhausted. Further amounts of underabsorbed overhead are handled in some other manner.

Although the practice of balancing overabsorbed and underabsorbed overhead against each other over a period of years has considerable theoretical justification, it is strongly objected to by some accountants and is seldom used.

Usual Practice of Disposing of Overhead Variances. The Committee on Research of the National Association of Accountants (Research Series No. 13, NAA Bulletin, vol. 29) made a field study of 63 companies using standard costs and summarized their practices in disposing of overhead variances as follows:

	No. of Companies
Overhead variance treated as period cost	49
Overhead variance divided between inventory and cost of sales	10
Loss variances treated as period cost, gain variances divided between inventories and cost of sales	4
Total	63

The Committee states:

With a few exceptions, companies having overhead standards which are up-to-date cost inventories at the standard overhead rate and write off variances. Most of these companies review their standard overhead rates once a year or whenever it is considered necessary because of changes in conditions. While overhead rates are reviewed at fairly short intervals, changes are not always made at each review. . . .

Companies which divide overhead variances between inventory and cost of sales or profit and loss do so because overhead standards are distinctly out of date, because activity substantially above normal has resulted in overabsorption of overhead with the consequence that inventories are stated in excess of actual cost, or because managerial policy in the company calls for actual costs in the financial statements.

Disposition Method Dependent upon Type of Rates Used. From a theoretical viewpoint the appropriate disposition of under- or overabsorbed overhead should depend in part upon the type of overhead rate used. If the normal overhead costs are estimates of actual costs and the normal activity level is expected activity level for the year, *the overhead balance at the end of the year should logically be closed through inventories and cost of sales.* This procedure yields **actual cost results** which were approximated in the estimates that produced the charging rates. If standard overhead costs and standard activity levels are used in determining charging rates, underabsorbed balances may be thought of reasonably as results of substandard activity, substandard efficiencies, and other unfortunate developments. This interpretation provides some justification for the treatment of overhead variances as period costs.

Disposition Method Dependent upon Analysis of Variances. It is often suggested that certain price factors in standard overhead costs are not within management control and thus should be included in product costs at actual figures. This idea, along with approval of closing of other variance figures as **period costs,** is suggested by Miller (NAA Bulletin, vol. 27) as follows:

1. Any variances which are caused by inactivity, waste, or extravagance should be written off, as they represent losses. They should not be deferred by capitalizing them in the inventory accounts. This would include quantity variances on material and labor as well as idle time and efficiency variances on burden.
2. An inventory reserve account should be established and charged with part of the price and budget variances to an extent which would bring the work in process and finished goods inventories up to, but not in excess of, current market values. The rest of the price variance amounts should be written off, as they represent excessive costs. In this way, the inventory accounts themselves will be valued at standard cost, while the inventories shown on the balance sheet will, as a whole, be shown at reasonable values through the use of the inventory reserve account. In addition, losses caused by excessive costs and inefficiencies will be shown in the operating statement for the period in which they occur.

For a discussion of the **frequency of revision of manufacturing overhead rates,** see section on Manufacturing Overhead and Product Cost.

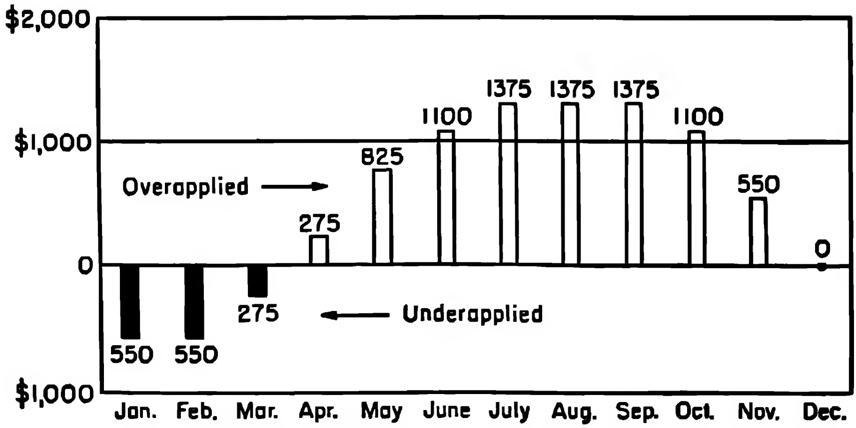


Fig. 7. Expected cumulative under- and overapplied overhead by months.

SEASONAL EFFECTS ON OVERHEAD BALANCES. Since overhead rates are usually established and used without change for a period of at least a year, a regular seasonal fluctuation of balances may be expected. Fig. 7, adapted from Gillespie (Cost Accounting and Control), shows the expected cumulative under- and overapplied overhead balance over the months of a full year. This chart shows no balance at the end of the year. This will be the case only if actual overhead costs and actual activity is in exact accord with the budgeted costs and normal activity used to determine the rate. Even though this could not be expected to happen, a tendency toward an annual rhythmic fluctuation such as that shown in Fig. 7 may be anticipated. It is noted that October, November, December, and January are slack months; March, April, May, June, and July are busy months; and that February, August, and September are average months in regard to production activity.

Idle Capacity Costs

DEFINITION OF IDLE CAPACITY. Some losses due to idleness of workers and of plant facilities occur in the most carefully managed plant. Certain of these losses are unavoidable, but excessive **idle time costs** represent a vital problem about which business management must be kept informed. It is the responsibility of the cost analyst to segregate these costs, place responsibility for them, and provide interpretations which will assist management in their control.

Kohler (A Dictionary for Accountants) defines **idle capacity** as "unused productive potential: said of a machine, operation, or plant not in use or only partially in use; it may be variously measured, as in tons of possible or additional output, or in hours available for use."

Idle time is often distinguished from idle capacity, and its cost is separated in the accounts. Kohler says that idle time is "lost time of men or machines arising from lack of business or of material, a breakdown of equipment, faulty supervision, or other similar cause whether or not avoidable. In the distribution of labor and production-center costs, it is often accounted for in a separate operating-expense account and regarded as an item of overhead."

IDLE CAPACITY AND FIXED COSTS. Idle capacity costs are represented mostly by the fixed charges of owning and maintaining plant and equipment and of employing services which are not used at their maximum potential. Increased mechanization of industry and lack of flexibility in the employment and release of workers have introduced a constantly greater proportion of fixed costs to total costs.

The Committee on Research of the National Association of Accountants (Research Series No. 16, NAA Bulletin, vol. 30) explains the relation between **fixed costs and capacity:**

> In order to carry on a manufacturing business, it is necessary to have buildings, equipment, and an organization. Some of these facilities must be acquired and kept in a state of readiness more or less, regardless of the volume of orders on hand at the moment. On the other hand, there are materials, labor, and services which need not be consumed unless goods are actually produced and sold. It is thus evident that fixed costs originate principally from the initial provision of capacity to do business, while variable costs represent the additional costs of utilizing the capacity to produce and to sell goods.

While costs are not inherently fixed, they become so as the result of policies established by management and decisions made at budget conferences (according

to the Committee). The following examples from this research report illustrate the ways in which fixed costs arise from such managerial decisions:

1. Decisions to acquire long-lived assets or to enter long-term contracts for the use of facilities for manufacturing and selling result in continuing cash outlays (for example, rentals and property taxes) and charges to amortize earlier expenditures (for example, depreciation). . . .
2. Readiness to manufacture and to sell requires trained personnel as well as buildings and machines. Hence in a going concern an organization of specified size is maintained regardless of whether or not it is fully utilized at the moment. Retention of at least a minimum number of employees on the payroll constitutes a source of fixed costs. . . .
3. Decisions to follow certain plans or policies result in expenditures that are not correlated with volume during a short period of time. Many of these costs are incurred to obtain future volume. Examples are expenditures for long-range planning, merchandise development, research, some kinds of advertising and sales promotion, training and education programs, many forms of plant maintenance, etc. . . .

The Committee concludes:

Thus fixed costs are costs of providing the capacity to do business. The amount of the fixed costs is determined by the volume of business for which provision is made and also by the specific methods and kinds of facilities chosen. It may be said that the amount of the fixed costs is determined by the volume of business anticipated and by the methods chosen to handle this business, rather than by the volume of business actually done.

If the full capacity provided to do business is utilized, all fixed costs are productive of benefits. If only a portion of the provided capacity is utilized, only a portion of the attending fixed costs are productive of benefits, and the remainder represents cost of idle capacity.

VOLUME VARIANCES AND NORMAL ACTIVITY. Definitions of idle capacity imply that, generally speaking, idleness expense is the unabsorbed portion of the fixed charges. Underabsorption of variable overhead is not subject to the same accounting procedure when standard cost methods are employed. In effect, the definitions given in the preceding paragraphs make the volume variance a measure of cost of idleness. This is correct under the following circumstances:

1. When normal capacity is set on the basis of practical operating level.
2. When operating interruptions are accurately determined, based on adequate scheduling and dispatching, proper functioning of internal transportation, proper control of materials, and good tool control and machine maintenance.

Volume variances do not measure idle capacity costs when normal capacity is based on **sales expectancy.** Different formulas and procedures are used in practice to determine idle capacity and its cost. Frequently the accuracy of the cost of idle capacity reported in a specific case depends on the accuracy with which a concern's **normal capacity** has been determined and on the base used in setting the normal.

Effect of Unbalanced Machines and Processes. Randlemen (NAA Bulletin, vol. 38) discusses the problem of normal capacity and excess capacity caused by unbalanced machines and processes:

Suppose Department A has a capacity of 20,000 units and Department B has a capacity of 30.000 units, obviously an unbalanced condition. What is practical capacity for the Company? Suppose, again, that Department A has a capacity of

20,000 units and Department B has a capacity of only 10,000 units, and Department A has no other outlet for its products. Again what is practical capacity for company purposes? It is probable that a preponderance of companies using normal capacity based on ability to produce only, define "normal" as the practical capacity of the plant as a whole (the practical capacity of each department considered individually), rather than scaling it down to the department of least capacity. Primary concern is with total productive capacity. This practice has the effect, characteristic of practical capacity burden accounting, of disclosing failure to maintain maximum commercial demand up to plant potential or to overcome equipment unbalance. Under it, if the practical capacity of the plant as a whole is used as the normal rate of activity, that portion of idle capacity resulting in unabsorbed burden, due to permanently idle equipment which cannot be disposed of, may be segregated from other idle capacity costs in the profit and loss statement and treated as excess capacity costs. This includes cost of maintenance, depreciation, taxes, insurance, etc., of all excess plant and equipment.

On the other hand, when average capacity is used as normal rate of activity, there is, of course, no problem of excess capacity as far as setting average commercial demand is concerned. . . . the average expected idleness (including excess capacity) due to lack of customer demand is included in the normal burden rate and applied to cost of production.

EFFECT OF BURDEN RATES. Churchill (NAA Bulletin, vol. 39) comments upon the variety of types of burden rates used and their relation to idle capacity costs. He states that the use of a burden rate based on theoretically available activity would allocate the productive time to the goods produced while the nonproductive time would be charged off as idle capacity. He adds:

The use of a burden rate based on the actual activity would allocate all the overhead costs to production. The use of the burden rates in between results in different amounts of the idle time costs allocated to production, and are the ones most commonly used in business today. . . .

The advantages claimed for each rate are for the most part sound. A close examination will disclose that these advantages arise because the different rates result in cost data suitable for different purposes and not that either rate is better than the other.

EFFECT OF NORMAL ACTIVITY-LEVEL CONCEPTS. The significance of volume variance data computed on the basis of different concepts of normal activity levels is discussed by Brummet (Overhead Costing):

The overhead volume variance, sometimes referred to as an activity variance or an idle time variance, is a measure of overhead cost deviation from standard caused by the failure of activity to reach that level which is implicit in the overhead charging rate. If overhead budgets are set up in terms of fixed and variable costs, the volume variance is usually computed as the product of the idle activity units and the standard fixed overhead cost rate per unit. In any case, it may be computed as the difference between the budgeted overhead for the activity level attained and the product of the overhead charging rate and the measure for the activity level attained.

Brummet gives the following example to illustrate this calculation:

1. Normal activity level	10,000 hours
2. Overhead budget at normal activity level	$20,000
3. Overhead charging rate (line 2 divided by line 1), or $20,000 divided by 10,000 hours	$2 per hour
4. Actual activity for the current period	8,000 hours
5. Budgeted overhead for the activity of the current period	$17,200
6. Volume variance [line 5 less (line 4 times line 3)], or $17,200 less $16,000	$ 1,200

Brummet observes that average activity rates charge overhead costs to products in an amount sufficient to include in product costs the total budgeted fixed overhead costs over an extended time period. Volume variances are, in such cases, measures of departures from averages. They may emphasize to management the range of activity level variations from the mean level, but they do not show possible needs for improvement. They may, in fact, encourage management to interpret them as seasonal or cyclical fluctuations caused by artificial phenomena which, almost by the laws of nature, tend to work themselves out over the long run. Such an interpretation may prove fatal to any business.

Average Activity Level. Volume variances resulting from the use of average activity levels are nearly useless, according to Brummet (Overhead Costing). They do not represent deviations from bench marks which are in any sense standards. They are simply a result of the accounting techniques and the historical activity levels of a particular enterprise. If average activity levels are used to charge overhead costs to products, supplementary methods should be used to keep management informed of economies which can be enjoyed only by increased exploitation of physical and manpower facilities which give rise to fixed cost commitments.

Practical Capacity Level. Brummet (Overhead Costing) concludes that:

In order for volume variances to reflect overhead costs of idleness and, therefore, possible advantages to be gained from increased volume, overhead rates should be established at a high utilization level of plant and manpower facilities. Conceptually such a level might be envisaged as a 168-hour week for 52 weeks each year. Such a concept might, indeed, provide interesting volume variance statistics

Since, however, there are usually substantial offsetting costs of operating at such a theoretical maximum level, and since often it is management's desire to operate at a considerably lower level in spite of profit motivation, this capacity is seldom if ever used. The practical capacity level is determined as a practical departure from this theoretical maximum. It makes allowances for management's desires and for inevitable but not altogether predictable losses of time due to production complications, but it does not reflect in any way the market potential of the company's products It may be explained as the level at which the company would operate if there were no problem of obtaining sales orders. It is a function of the size and capabilities of physical and manpower facilities.

When the practical capacity concept is used in charging overhead costs to products, the volume variance represents a cost of unwanted idleness It is the measure of the failure to obtain management's concept of an optimum exploitation of fixed resources Here is to be found a useful reminder to management In order to develop meaningful volume variance data, a high level of activity (or that often referred to as practical capacity) appears to be the most appropriate activity basis for overhead costing of products

An intelligent approach to the subject of **normal activity** as it relates to volume variances and measurements of costs of idle capacity should include an awareness of the following points:

1. Idle capacity must remain a somewhat flexible concept; it is an individual problem in which many special situations must be considered.
2. Management is interested in idleness, its causes and costs, as well as in the more restricted accounting concept of idle capacity.
3. In many cases the volume variance, or unabsorbed fixed overhead, is not the measure of idle capacity cost.
4. Special reports of idle equipment time and its cost, showing complete segregation of causes, are needed.

5. Wide differences exist regarding the extent to which idle time costs and idle capacity cost should be charged to the product produced. Possibly a majority of cost accountants agree that excess capacity costs should be excluded from product cost, while the expense of maintaining a key organization should be included.

CAUSES OF IDLE CAPACITY. Using a threefold classification, Churchill (NAA Bulletin, vol. 39) breaks down causes of idle capacity as follows·

1. Production causes.
   a. Repetitive machine adjustments
      (1) Setup and change over.
      (2) Repairs and adjustments
   b. Lack of materials or tools.
      (1) Internal.
      (2) External.
   c. Lack of supervision, inspection, instruction.
   d. Lack of power.
      (1) Internally produced.
      (2) Externally produced.
2. Administrative causes.
   a. Excess plant for anticipated expansion
   b. Production balance.
   c. Special machines used for one or two jobs
   d. Nucleus or core of labor force.
   e. Some strikes.
3. Economic causes.
   a. Seasonal.
   b. Cyclical.
   c. Industrial

Production Causes. It is clear that each cause is traceable in part to poor organization for operation. If there is a lack of work, for example, it may be due to poor planning, slow or delayed engineering analysis, poor routing, scheduling, or dispatching, or lack of sales orders. It is seldom possible to eliminate or to control completely those causes, but a positive knowledge of the extent of **machine idleness** and its causes provides management with something constructive to work on.

Loss of time due to any of these causes may be either entirely within or without the control of the factory management. Action must be based on proper reports. There are a variety of forms of **machine utilization** or **idle machine reports.** Fig. 8 shows one by Neuner (Cost Accounting). Unlike some such reports, this one translates the idleness into dollars and cents of loss by multiplying the time lost by the fixed component of the burden rate. The filling out of such a report requires some analysis of the cause of idleness of each machine. The report for each department should be reviewed by the factory superintendent with the foreman. This should aid in minimizing the causes of idleness in the future. This report may also serve to stop the purchase of additional units of equipment which are not being utilized fully now, and in some cases may stimulate management to dispose of equipment which is shown to be unused for a long period. Such reports or summaries thereof are helpful to the production scheduling department and to higher executives in planning production and allocating work to the different departments.

Determination of the **responsibility for idle time losses** is difficult. The same factor in a given department may be due to a number of different conditions

IDLE MACHINE REPORT
DEPARTMENT #106 CUTTING

For month ending July 31, 19—
Foreman: A. B. Howard

Machine No.	Standard Hours	Actual Hours			Idle Hours							% of Standard	Burden Rate for Idle Time	Cost of Idle Time	Remarks
		Regular	Overtime	Total	No Operator	No Materials	Repairs	Awaiting Setup	Awaiting Tools	Awaiting Instructions	Total				
C-102	160	160		160											O.K.
C-103	160	150		150		10					10	6.25	$3.10	$31.00	Material held up in drilling dept.
C-104	160	160		160											
F-110	160	140		140				20			20	12.5	1.80	36.00	Improper scheduling.
F-111	130	160	15	175									1.80	27.00*	To make up loss of Mach. #110.
F-112	130	125		130					3	2	5	3.85	1.80	9.00	Job instructions not on hand.
Total	900	895	15	915		10		20	3	2	35	2.77		49.00	

* Credit for overtime.

Fig. 8. Idle machine report.

at different times. For example, idle time caused by waiting for work in Department 5 may be due to poor planning in the factory office, or it may be due to a failure to maintain scheduled production in Department 4. Further investigation may show that Department 4 suffered machine interruptions, necessitating extensive repairs. This in turn may be due to faulty maintenance practice. It might have been due to failure of power or failure to obtain the necessary parts or raw materials for processing. Innumerable reasons may lie at the root of the idle time in Department 5. The cost analyst is therefore always confronted with the necessity of judging which of the many reasons or excuses offered is the real cause of the idle time loss.

Administrative Causes. In this category of causes of idle capacity is to be found the results of many administrative decisions made at various levels of management. When **plant additions** are made, excess capacity is often provided for anticipated future growth. Idle capacity costs are incurred at least for a short period of time. The **acquisition of new plant** originally designed for a purpose different from that anticipated by the purchaser may cause excess capacity to exist. In order not to lose key salaried personnel and skilled wage earners permanently, management may be reluctant to dismiss such employees in periods of recession, thus accounting for idle capacity.

The general tendencies toward enforced **stability of labor** within a company and recognition of seniority of employees contribute to the problem of idle time costs. In a situation where limited production is scheduled for operations requiring highly skilled workers, and as a result the oversupply of skilled workers is used in less skilled roles, the excess cost of this skilled labor may reasonably be attributed to idleness in the limited volume operations. Administrative decisions to merge with other companies, relocate plants or production operations, diversify or retrench product offerings, or to automate operations may cause at least temporary idleness cost.

Although much of the cost of idle capacity resulting from administrative causes is based upon prudent actions of responsible personnel, it is nevertheless important that management be informed of its nature and amount.

Economic Causes. When the demand for certain goods is **seasonal,** as in coal, ice cream, furs, and even automobiles, production cannot be evenly distributed, especially where there is danger of deterioration or where carrying charges for a large stock are too great. Unused capacity can be reduced sometimes by taking on other seasonal products whose peak demand coincides with the slack seasons of the first product. Examples of such cases are the combination of milk and ice-cream production, the sale of coal and ice, or the manufacture of steel toys by an automobile stamping company.

Cyclical fluctuations are similar to seasonal fluctuations, but they exert their influence over longer periods of time. As with seasonal fluctuations, management is limited in the control which it can exert over this uneven nature of demand for products. Some benefits may result when effective long-range planning includes an active sales and product policy.

Seasonal and cyclical fluctuations make more difficult the task of the cost analyst in interpreting the results of operations. He must keep in mind the extent to which results are affected by these phenomena and make mental if not actual adjustments for them.

Under the heading of **industrial causes** come those idle time losses due to general shifts in demand, producing overcapacity in some industries at a given

time. Also, relocation of companies and industries caused by change of location of raw materials, population movements, changes of transportation means or facilities, or changes of need for proximity of a favorable labor market often create overcapacity.

SEGREGATION AND ACCUMULATION OF IDLE CAPACITY COSTS. The ultimate aim of the production man is to eliminate idle time costs; failing that, to place responsibility for them and to minimize them. Since **idle time** is caused by a number of different factors, it is necessary to determine which factor is causing the idleness in a particular case. Once this is known, management is in a position to take intelligent action to eliminate or reduce the idleness. This is not likely to occur if all idle time losses are lumped together, with no indication as to how much is caused by each of the many different factors, such as lack of sales, poor scheduling, and machine breakdown because of poor maintenance.

Blocker and Weltmer (Cost Accounting) outline a useful method for the **segregation of idle time costs.** They advocate classification of idle time as a separate factor in daily time tickets:

> Each ticket should show the amount of time expended on each production order, the time consumed in performing indirect labor as a regular or special assignment, and the hours of nonproductive labor or idle time If idle time is a normal condition of plant operation, the following entries are made when the indirect labor payroll, classified as to indirect labor and idle time, is distributed:
>
> Entry in general ledger:
>
> | | | |
> |---|---|---|
> | Factory Overhead control .... | \$.... | |
> | Payroll control .... | | \$.... |
>
> Entry in subsidiary records:
>
> Charge appropriate departments in the standing order for indirect labor; charge the appropriate departments in the standing order for idle time.
>
> A separate standing order is maintained for idle time so that executive attention is directed to the idle time factor and to the department responsible.

Idle time due to abnormal conditions beyond the control of the production division, however, should be treated as a **general profit and loss charge,** according to Blocker and Weltmer (Cost Accounting). They cite as examples a strike, a lockout, fire, wind, or water damage, any one of which may require the maintenance of a skeleton force of workers even though there is no immediate productive work to be done.

RESPONSIBILITY FOR VOLUME VARIANCES. The Committee on Research of the National Association of Accountants (Research Series No. 12, NAA Bulletin, vol. 29) states:

> Volume variances are rather commonly viewed as the result of outside circumstances over which the business has no control. While this may be true to a certain extent, it would seem that it is the function of management at the over-all planning and policy-making level to secure a proper balance between production facilities and sales in order that losses from nonutilized capacity may be kept at a minimum. For this reason some companies consider top management responsible for volume variances. Such control is necessarily a long-range problem, and a volume variance in any given period may be something over which little direct control can be exercised.

In the course of this Committee's study, a few companies reported exceptions to the general attitude toward **volume variances.** These exceptions disclose a

field where some immediate control over volume variances may be possible. Practice of these companies is summarized below:

Company No. 1: The sales manager is considered responsible for volume variances, since he is expected to obtain the volume of business used in establishing the standard overhead rate.

Company No. 2: Departmental supervisors are held responsible for idleness due to machine breakdowns, failure to have materials or operators ready, and similar causes of delay in the factory.

Company No. 3: A manufacturer of office machines has a production stabilization program whereby the factory works at a steady rate and product is accumulated in inventory during seasonal periods of slack sales. The production planning department is held responsible for volume variances in production, since such variances result from faulty planning of operations.

SECTION 11

JOB ORDER COST SYSTEMS

CONTENTS

SECTION 11

JOB ORDER COST SYSTEMS

Nature of Job Order Costing

PURPOSE OF SYSTEMS. Some manufacturing companies produce one or more standard products for stock. Their manufacturing processes are firmly established, and work flows continuously through the processes. Such companies want to know the production costs of each process. They employ a **process cost system** to get this information. Other manufacturing companies are not engaged in producing goods for stock. Instead, they engage in production only when they receive an order from a customer. No two orders are necessarily alike, nor do all orders always pass through the same manufacturing processes. Consequently, cost information must be accumulated for each order or job. The system of accounting that provides information in this way is called a **job order cost system.**

There is one exception to the foregoing. Some companies which produce standard stock products manufacture their products in separate, clearly distinguishable **batches or lots.** When the cost of producing each batch is of importance in a given case to management, the company may elect to employ a job order cost system as the most satisfactory means whereby such information on batches or lots may be obtained.

The problems involved in combining **material, labor,** and **manufacturing overhead costs** in job order situations are dealt with in this section. The sections on Materials and Labor Costs, and the four sections on Manufacturing Overhead, discuss in detail the methods of treatment of each of these three elements of manufacturing cost.

DEFINITION. Kohler (A Dictionary for Accountants) defines **job order costing** as follows:

> . . . a method of cost accounting whereby cost is compiled for a specific quantity of product, equipment, repair, or other service that moves through the production process as a continuously identifiable unit, applicable material, direct labor, direct expense, and usually a calculated portion of the overhead being charged to a job order; distinguished from process costing.

The terms **specific order, production order, job lot** cost system, **job** costing (or **lot** costing) are often used as synonyms for job order costing. Anthony (Management Accounting) makes this distinction:

> A pure **job cost** system is one in which the costs are collected for each individual job worked on. A "job" may mean one unit of product (e.g., a turbine or a house), or it may mean many units of identical or similar products covered by a single production order, e.g., books or shirts. When the job consists of more than one unit of product, the system is often called "job-lot costing" or simply "lot costing."

Vance (Theory and Technique of Cost Accounting) describes the job order method as follows:

Job order cost accounting is used where the cost of separate jobs is wanted. Jobs are kept separate and their costs separately compiled where the materials and work done vary from job to job, and especially where several different jobs may be worked on at the same time. The important condition for use of job order costs is that individual jobs be separately identified in the operating departments. This may be done even where the product is uniform, but the method is used mostly by concerns which make a variety of assembled products. Job costs are used in construction and by custom shops which manufacture to the customer's specifications. They are also used by many concerns manufacturing for stock.

JOB ORDER INDUSTRIES. Among the industries that employ job order cost systems are: asphalt paving, construction, foundry, furniture, hardware, heavy machinery, luggage, machine shops, paper and paper products, printing, rubber goods, shipbuilding, textile finishing, and toys.

JOB ORDER COST TRANSACTIONS. Vance (Theory and Technique of Cost Accounting) illustrates the use of separate **work-in-process accounts** for each element of cost in the flow chart of job order cost accounting given in Fig. 1.

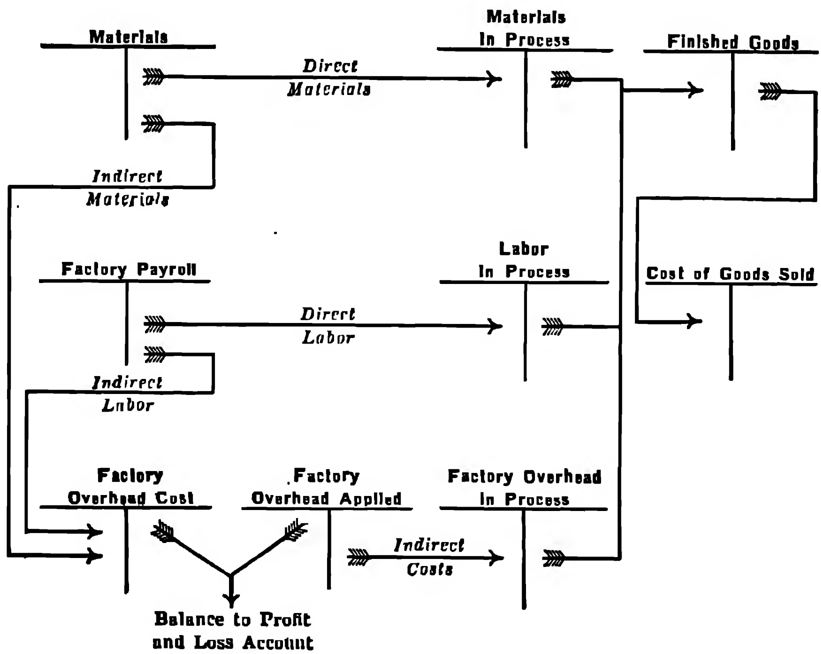


Fig. 1. Flow chart of basic general ledger procedure for job order cost accounting, using multiple work-in-process accounts.

In order to illustrate the basic mechanics of a **job order cost system,** transactions for a hypothetical company are given here and are posted directly to ledger accounts.

System Case. The Lins Manufacturing Company, which builds machine tools for special purposes in accordance with customers' specifications, begins the month of January with raw materials and supplies (stores inventory) of $50,000, and work in process of $75,000 (consisting of Job No. 1743 of $40,000, Job No. 1747 of $23,000, and Job No. 1749 of $12,000). During January, the following **transactions** occurred:

1. Materials and operating supplies of $45,000 were purchased and received.
2. Production orders were issued for Jobs Nos. 1751, 1752, and 1753.
3. Gross earnings of all personnel engaged in manufacturing activity were $220,000 for the month, exclusive of the Company's contributions of $4,950 under the Federal Insurance Contributions Act and $6,600 for unemployment taxes, both federal and state.
4. Total material requisitions during the month were $40,000, of which the following amounts constituted direct materials used on jobs:

Job No. 1743	None
1747	$ 2,000
1749	6.000
1751	10,000
1752	9,000
1753	8.000
Total	$35,000

   The remaining $5,000 was indirect material.
5. Upon analysis, time tickets of all manufacturing personnel revealed that the salary cost for the month applicable to the various jobs was:

Job No. 1743	$ 20,000
1747	30,000
1749	40,000
1751	35,000
1752	25.000
1753	20.000
Total	$170,000

   Supervision and indirect labor amounted to $50,000.
6. Manufacturing overhead was charged to production at the rate of 50% of direct labor cost.
7. Depreciation and other manufacturing costs were $21,000.
8. Unused materials of $500, requisitioned for Job No. 1751, were returned to stores.
9. Three jobs were completed, shipped, and billed, as follows:

	Sales Price
Job No. 1743	$ 95,000
1747	80.000
1751	75,000
	$250,000

Solution. *These transactions are set up in the following ledger accounts:*

GENERAL LEDGER ACCOUNTS

Raw Materials and Supplies

Bal.	$50,000	(4)	$40,000
(1)	45,000		
(8)	500		
55,500*	95,500*		

Balance Account (for sundry accounts)

(9b)	$250,000	Bal.	$125,000
		(1)	45,000
		(3)	231,550
		(7)	21,000
		172,500*	422,550*

Work in Process

Bal.	$ 75,000	(8)	$ 500
(4)	35,000	(9a)	202,000
(5)	170,000		202,500*
(6)	85,000		
162,500*	365,000*		

Manufacturing Payroll

(3)	$220,000	(5)	$220,000

Manufacturing Overhead—Actual

(3)	$ 11,550		
(4)	5,000		
(5)	50,000		
(7)	21,000		
	87,550*		

Cost of Goods Sold

(9a)	$202,000		

Sales

		(9b)	$250,000

Manufacturing Overhead—Absorbed

		(6)	$ 85,000

WORK-IN-PROCESS LEDGER: JOB COST SHEETS

Job No. 1743

Bal.	$40,000	(9a)	$70,000
(5)	20,000		
(6)	10,000		
	$70,000		$70,000

(2) **Job No. 1751**

(4)	$10,000	(8)	$ 500
(5)	35,000	(9a)	62,000
(6)	17,500		
	$62,500		$62,500

Job No. 1747

Bal.	$23,000	(9a)	$70,000
(4)	2,000		
(5)	30,000		
(6)	15,000		
	$70,000		$70,000

(2) **Job No. 1752**

(4)	$ 9,000		
(5)	25,000		
(6)	12,500		
	$46,500*		

Job No. 1749

Bal	$12,000		
(4)	6,000		
(5)	40,000		
(6)	20,000		
	$78,000*		

(2) **Job No. 1753**

(4)	$ 8,000		
(5)	20,000		
(6)	10,000		
	$38,000*		

* Pencil footings and balances.

LINS MANUFACTURING COMPANY
GENERAL LEDGER TRIAL BALANCE

January 31, 19__

Raw Materials and Supplies	$ 55 500	
Work in Process	162,500	
Cost of Goods Sold	202,000	
Sales		$250.000
Balance account		172,550
Manufacturing Payroll	....	....
Manufacturing Overhead—Actual	87,550	
Manufacturing Overhead—Absorbed		85,000
Totals	$507,550	$507.550

LINS MANUFACTURING COMPANY

PROOF OF JOB COST SHEETS

January 31, 19__

Job No. 1749	$ 78,000
Job No. 1752	46,500
Job No. 1753	38,000
Balance in Work-in-Process control account	$162,500

Comments on Solution. Inasmuch as the purpose of the illustration is to indicate how **production accounts** are interrelated in a job order cost system, debits and credits to nonrelevant accounts were posted to a single balance account in order to maintain debit-credit equilibrium. Comments on selected transactions are:

Transaction 2: Copies of **production orders** are sent to the accounting department to advise it of scheduled production so that cost sheets can be set up to receive forthcoming manufacturing costs.

Transaction 3: Social security taxes paid by the Company are charged to manufacturing overhead in this illustration, although a strong case may be made for charging them to manufacturing payroll. If this alternative is employed, its effect upon the rate of manufacturing overhead should be noted. By increasing direct labor cost, which in this illustration is the base for application of manufacturing overhead, and by decreasing the amount of manufacturing overhead costs, a lower rate of application would result.

Transaction 4: Materials and supplies which are identified as applicable to specific jobs are called **direct material** and are charged directly to the jobs to which they relate (in this case $35,000) The remaining materials and supplies (or **indirect material**) are charged to manufacturing overhead (often called factory burden, factory service, or factory overhead), but they ultimately get charged back to jobs when the manufacturing overhead is distributed.

Transaction 5: The difference between the manufacturing payroll of $220,000 and the **direct labor** of $170,000 represents **indirect labor** and supervision not directly attributable to any one job. It is charged to Manufacturing Overhead—Actual in the same manner as indirect material.

Transaction 6: On the theory that manufacturing overhead is roughly proportional to labor costs charged to jobs (not always the case), direct labor cost was selected at the beginning of the month as a basis upon which manufacturing

overhead could be applied currently to **job cost sheets**. Since it was estimated that total manufacturing overhead would be one-half of total direct labor costs, a rate of 50% was established. Accordingly, for every dollar of direct labor charged to a job, 50 cents of manufacturing overhead is charged. Although dependent upon estimates, this technique enables manufacturing overhead to be accumulated on jobs on an up-to-date basis. Otherwise, job costs would not be available currently.

Transaction 9: Since each job is the result of a special customer's order, it is shipped directly to the customer when completed. Therefore completed job costs (9a) are charged directly to Cost of Goods Sold instead of to Finished Goods Inventory, although it would not be wrong to "wash" all completed production through Finished Goods Inventory. The price billed to customers, $250,000 (9b), is, of course, credited to the Sales account and (in this illustration) debited to the Balance account in lieu of Accounts Receivable or Cash.

GENERAL PRINCIPLES. When viewed in their entirety, most job order cost systems are very much alike. All manufacturing costs are capitalized until a finished unit is sold. Then the costs identified with that unit are transferred to a **cost-of-goods-sold account** so that they may subsequently be matched against sales revenues in the process of measuring periodic income. This basic principle is often obscured by masses of detail and misleading account captions.

In a **job order cost system**, as in other systems, three elements of manufacturing cost—**direct material, direct labor,** and **manufacturing overhead**—are recognized. None of these elements is an expense when its cost is incurred initially. The incidence of cost is actually an exchange. For example, the salary paid to a drill press operator involves a reduction in cash and an increase in work in process because of the value that the operator has added to the product. By the same token, depreciation on the drill press is an exchange. A portion of the machine's service capacity is used up in adding value to goods that are being produced. One asset, work in process, increases; another asset, machinery, decreases.

Inasmuch as direct material and direct labor costs are charged to work in process, there is less confusion and misunderstanding over them than there is with manufacturing overhead. **Manufacturing overhead** consists of a variety of manufacturing costs that have one thing in common. Each, either by its nature or by virtue of prohibitive accounting cost, cannot be identified with a specific lot of production. As a result. all are dumped into a common melting pot, manufacturing overhead. The mix that results is then charged to work in process and distributed to the various jobs that are being produced. Because of the heterogeneous nature of manufacturing overhead, management of a company is interested in ascertaining its various components, both as to kind and amount. Consequently separate accounts are kept on the books for each component Unfortunately these accounts are often labeled as expense accounts (such as depreciation expense or insurance expense) when, in fact, they are not. All manufacturing overhead finds its way back to the inventory of work in process.

Variations in individual job cost systems may be due either to the extent to which accounting refinements are employed in an effort to get more meaningful costs or to the **management philosophy** adopted with respect to certain kinds of costs. When different job cost systems are compared, these considerations are responsible for producing variations in costs of individual jobs, variations in total inventories (both work in process and finished goods), and variations in costs of goods sold.

System Requirements

PRODUCTION PLANNING DEPARTMENT. Since each job has its own characteristics that cause it to differ from other jobs, analysis is necessary in order that production can be planned and scheduled in the most efficient way. The department responsible for such planning and scheduling is the **engineering department,** sometimes called the **planning, production planning,** or **production planning and control department.** This department, upon receipt of a customer's order, prepares blueprints (if not furnished by the customer), determines required materials, schedules the work through the plant, and issues a production order. It also furnishes, in cooperation with the accounting department, cost estimates that are the basis of bids for prospective orders.

PRODUCTION ORDER. March (Cost Accounting) defines production orders, or **factory orders,** as simply ". . . instructions to shop personnel to do work." Production orders vary from oral instructions in the smallest of plants to detailed **written instructions** that may contain:

1. Date the order was prepared.
2. Job order number.
3. Description of the items to be produced.
4. Number of units to be made.
5. Date work is to start.
6. Date work is to be completed.
7. Required materials (material requirements may be itemized on a separate **bill of materials**).
8. Sequence of manufacturing operations (this information is sometimes placed upon a **route slip,** or a **move ticket,** that accompanies the work through the plant).
9. Authorization signature.

In addition, the production order may be accompanied by written instructions, if it is necessary to elaborate on any phases of production, and by detail drawings. A copy of the production order is sent to the accounting department in order for that department to set up a job cost sheet upon which production costs will later be accumulated. To ensure accurate cost accumulation, each production order preferably is limited to the production of only one kind of item. Lang–McFarland–Schiff (Cost Accounting) illustrate a production order or route sheet in Fig. 2.

JOB ORDER NUMBER. The production planning department assigns to each production order a number that is called a job order number. This number is the identifying means whereby direct costs relating to a production order (or job) are reported to the accounting department. Although the job order number assigned to a given job may be merely the next unassigned number in a series of consecutive numbers, it may be elaborated on by adding code numbers or letters to reveal additional information about the job. For example, Walsh (NAA Bulletin, vol. 38) states:

> . . . The class code number summarizes the following information: the first two digits signify the type of work printed (i.e., dress goods, shirtings, pajamas, etc.), the third digit indicates whether the cloth has been printed on one side or both sides, the fourth digit designates the basic cost per yard for printing, the final digits, following the dash, represent the price class.

PRODUCTION ROUTING AND OPERATION SCHEDULE

Part Name Chop Knife — Model 52C — Part No. 7392

Date 1/22 — Cancels Issue No. — — This Issue No. 4314 — OKed by J.M.

Oper. No.	Operation	Station No.	Speeds	Feeds	Task: Set up	Task: Std Time
[illegible]10	[illegible]ivet	7-R-2			.5	3.0
612	Weld	W5			—	2.5
619	[illegible]	7-1			[illegible]	3.0
70[illegible]	[illegible]uff Rims	H7-4			.4	3.0
[illegible]	[illegible] Bolster	H7-6			.4	3.5
7[illegible]	[illegible]ish Handle	H7-7			—	4.0
800	Wash	C7			—	1.0
819	[illegible]pect	C7			—	1.0

Fig. 2. Production order or route sheet.

BILL OF MATERIALS. This is a complete list of all the materials required to produce a given job. The form illustrated in Fig. 3 is on tracing cloth which permits blueprint duplication. The last three columns are blacked out on the tracing so that they appear white on the blueprint and therefore are available for posting costs.

Bills of materials may expedite issues of materials by serving as substitutes for material requisitions. Like material requisitions, they are authorizations to the storeroom to issue required material. Four copies may be prepared, as follows:

1. Copy for storeskeeper
2. Copy for accounting department (balance-of-stores clerk and cost clerk).
3. Copy to accompany production order.
4. Copy for files of production planning or engineering department.

A bill of materials is also used in determining material costs of a proposed order. It is sent to the balance-of-stores clerk, who notes unit costs on it for the purpose of determining total material cost. If certain materials are not in stores, the bill of materials is sent to the purchasing department for the required cost data. This procedure also serves to alert the purchasing department to the possibility of having to obtain certain materials in the near future.

STANDING ORDERS. Since all direct costs in a job order cost system are accumulated by number (the job order number), it is convenient to identify **indirect manufacturing costs** by number as well. A set of standing orders may be established for this purpose. The standing orders are simply numbers assigned to individual manufacturing overhead accounts. The sheets that comprise the subsidiary ledger for manufacturing overhead often come to be called "standing orders." The number of standing orders depends entirely upon the extent to which manufacturing overhead is analyzed. The term is also used to indicate an order for the performance of broad classes of work that must be carried out regularly, such as the maintenance or repair of property. In process cost accounting, the term "standing order" may be used in lieu of **standing production order,** which is the authorization to the factory to engage in continuous production of a standard item.

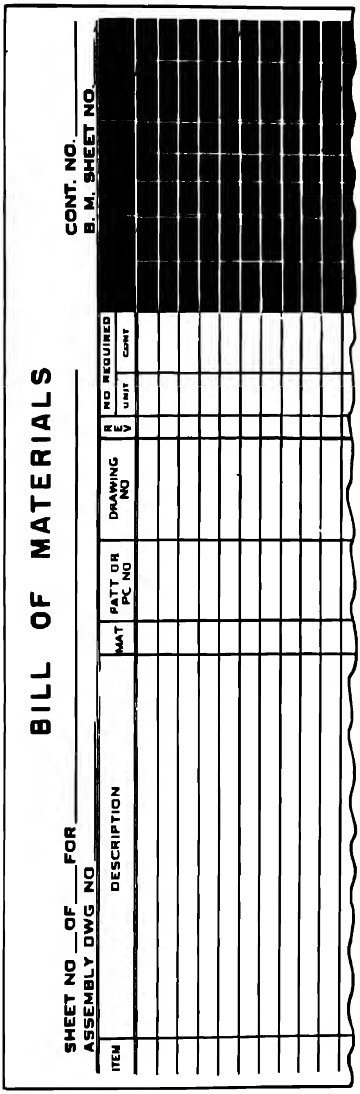


Fig. 3. Form of bill of materials.

COMPLETED PRODUCTION REPORT. When a job is completed, the accounting department must be advised if it is to prepare a completed job report (see discussion on Reports in this section). The foreman or a shop clerk in the last department through which a job passes must fill in a completed production report (Fig. 4). In some cases this information may be noted on the production order,

Completed Production Report   Date ______________________

Job No. ______________   Dept ______________________

No. of units completed ____________________________________

Remarks ____

____

____

Signature ______________________

Fig. 4. Form of completed production report.

which may be routed via the accounting department. In plants such as printing plants where overruns are common, the number of units actually produced will rarely agree with the quantity stated in the production order.

Accounting for the Elements of Cost

OBJECTIVE. The primary objective of a job order cost system is to charge correctly the three cost elements of direct materials, direct labor, and manufacturing overhead to the individual **job orders.** Charging direct materials costs is not very difficult because materials withdrawn from stores for a given job can be measured with reasonable precision. Charging direct labor costs is more difficult because of problems and complexities inherent in any **timekeeping system.** Charging manufacturing overhead costs requires careful analysis to ensure that they will be allocated to individual jobs on an equitable basis.

MATERIAL COSTS. In dealing with material charges, a definition of **direct materials** is necessary. Gillespie (Cost Accounting and Control) says, "A direct material is one which (a) is identified with a particular product and (b) is feasible to measure and charge to the cost sheets for particular production orders." With respect to condition (b), he further states, "Indirect material is identified with particular units of product, which it is not considered feasible to measure and charge to the cost sheets of specific production orders." Thus, **indirect material** is charged to manufacturing overhead instead of to job cost sheets. The justification for carrying some identifiable material as indirect is based on the fact that the more detailed accounting handling required for direct materials is more expensive than for indirect materials. Therefore many materials of trivial cost are classed as indirect merely because any benefit derived from classifying them as direct would not justify the increased cost of accounting.

In addition to the foregoing conditions, there are other materials and supplies used in production that are not identified with specific production. Gillespie (Cost Accounting and Control) says, ". . . there are certain physical goods,

known as factory operating supplies, which are used as and when production takes place but which do not actually go into the product." Like indirect materials, **operating supplies** are charged to manufacturing overhead but for a different reason. They are not identifiable with specific items produced.

Circumstances are sometimes such that material which has all the earmarks of being direct is treated as indirect and is charged to manufacturing overhead. Arnold (NAA Bulletin, vol. 35) cites a manufacturing overhead rate of 145% in one department in comparison with 320% in another department within the same company. He explains:

> . . . the major difference . . . is that, in the latter burden center, material is charged to one of its overhead accounts. There is a special reason for so treating material in this department. The net effect of the standard minute system used in the wage incentive plan is to create a direct correlation between the length of time the operator has the spray gun trained on the part and the amount of money he is paid. Hence the direct labor dollar serves as a convenient basis for the distribution of this type of material cost.

This case illustrates how a saving in accounting cost is achieved without affecting the accuracy of cost data.

Material Requisition. Although **bills of material** (Fig. 3) may be the media through which required materials are issued to jobs, there are circumstances under which jobs require additional materials. When these materials are issued, a **material requisition** is prepared (see section on Materials). This form is also used to record issues of operating supplies. It must provide space for indicating either the job order number or the standing order number. Issues that are to be charged to different job or standing orders should not be recorded on the same material requisition.

Material Credit Slip. If the wrong kind of material is delivered to a job or if material is left over after completion of a job, it must be returned to stores. Record of the return is made on a material credit slip which is similar to the material requisition. Because of this similarity in appearance, it is often printed on paper of a different color.

Costing Material Requisitions. In situations where a job order cost system is expected to provide daily cost information, the method of costing material issues requires careful thought. Oftentimes material costs are delayed because a method like the **weighted-average method** creates a bottleneck at the point of recording unit costs on material requisitions. For simplicity and expediency in costing, nothing equals **standard costs** because they remain as predetermined constants over a period of time.

Posting Material Costs. Bills of material and material requisitions are sent from the storeroom to the **balance-of-stores clerk.** The latter inserts unit costs on both bills and requisitions, makes extensions, and credits the proper stores cards for the cost of materials issued.

Bills of material, material requisitions. and material credit slips (which are treated as deductions) are analyzed and totaled daily. A daily summary is entered in the **material issues journal,** illustrated in Fig. 5. The monthly totals in this journal are posted to the **general ledger** as follows:

Dr. Work in Process	$28,976 21	
Dr. Manufacturing Overhead	371.06	
Cr. Materials and Supplies		$29,347.27

19__		Work in Process, Dr.	Manufacturing Overhead, Dr.	Materials, Cr.
Jan.	1	$ 1,742.56	$	$ 1,742.56
	2	693.10	20.50	713.60
	31	972.38		972.38
		$28,976.21	$ 371.06	$29,347.27

Fig. 5. Material issues journal.

Careful consideration must be given to the amount of detail that is to be posted to job cost sheets. If reference is made frequently to job cost sheets for the purpose of obtaining detailed material information, then the **cost clerk** should post materials in itemized detail to them. If not, considerable posting time will be saved by sorting bills of material, material requisitions, and material credit slips by jobs. The cost clerk will then post only one figure to each job cost sheet for the issues of any given day. As regards charges to manufacturing overhead, **material requisitions** may be posted daily to subsidiary ledger accounts, or they may be accumulated during the month for sorting and posting once at the end of the month. The latter procedure will save time and not add significantly to the month-end work load if the requisitions are not too numerous.

LABOR CHARGES. In any cost system, payroll accounting falls into two distinct parts. The first involves computation of gross pay earned by each employee and subsequent payment (see section on Labor Costs). The second involves analysis of the total payroll in order to distribute labor costs to appropriate accounts. In a job order cost system, cost distribution involves considerable detail and numerous problems. Woosley (NAA Bulletin, vol. 30), states, "The time-keeping department is really the backbone of a good cost system." He also says that, ". . . unless we know just how much time and money is spent on each job and on each operation, we cannot hope to have accurate cost information."

Direct Labor vs. Indirect Labor. Only that portion of manufacturing labor cost, which is classed as **direct**, is charged to job cost sheets. The remainder, **indirect labor**, is charged to manufacturing overhead. The principle underlying this division into two classes is the same as the one that was cited earlier in connection with materials. Neuner (Cost Accounting) defines direct labor as follows: "Direct laborers are those actually working on the article manufactured in such a manner and for such a length of time that the cost of their labor can be identified economically with a specific job lot of goods."

Care is necessary to avoid misunderstanding in the use of the words "direct" and "indirect" in connection with the classification of indirect labor. Some employees, such as power plant personnel, work in only one cost center. Since the cost of their labor cannot be identified with specific lots of production, it is classed as indirect labor. Although this cost is charged to manufacturing overhead, it is identifiable with a specific **cost center**, and consequently it is a **direct cost** of that center. A play on words could identify this cost as direct, indirect labor. Other

employees, like the plant manager and his assistants, are not identifiable with specific cost centers. Their time is prorated to the various cost centers as **indirect costs** of the centers.

Problems of labor classification are common in job order industries. This is illustrated by the following exchange from an NAA discussion forum on job order industries at an annual convention of the National Association of Accountants (NAA Bulletin vol. 37):

> "When is the line drawn to separate direct from indirect labor?" a member of the printing industry asked. His actual problem was whether to consider the labor of "washing up" a press when going from a job in black ink to a job in colored ink, as direct or indirect. One response to the question was that such labor is considered direct and charged to the previous job. . . .

Clock Cards. Clock cards are an integral part of many cost systems. They constitute the attendance records of employees, thus being significant in computing gross earnings.

Time Tickets and Time Cards. In order to know exactly how much time is spent on individual jobs or operations, a record must be made at the point of production and sent to the accounting department. Neuner (Cost Accounting) says, "To collect this information systematically for workers on an hourly wage, two forms have been devised. These are the **individual job time ticket** and the **daily job time report.** The same results are obtained from the use of each."

Unit of Time Measurement. In a job order industry, an employee may work several days on a given job or he may work on many jobs in the course of a given day. In order to reduce clerical detail, some companies do not attempt to report time in exact minutes but in terms of arbitrary units of time. Devine (Cost Accounting and Analysis) writes:

> Keeping workers' time in the factory and on specific jobs seldom requires that the exact number of minutes be used. Some firms are satisfied to keep job time to the nearest fifteen minutes. Perhaps one of the most convenient methods is to use the decimal system, i.e., units of six minutes. . . . Job time clocks are often designed to record the time in tenths. These recorders shift at the end of each six minutes. Some error is introduced when jobs are started and stopped at different points along the six-minute intervals. It is possible, for example, for a job to get almost two units of service while being charged for only one unit, while another job may be charged for two units when the actual lapsed time is only slightly more than six minutes.

Vacation Time. World War II revealed a flaw in the cost systems of many job order industries. It was the practice to charge vacation time to manufacturing overhead. With the emphasis on production, many vacations were deferred until cessation of hostilities. Then, heavy charges for vacations, combined with curtailed production, pushed overhead rates up to meaningless heights. This also indicated that past production costs had been understated.

Where workers receive paid vacations, it should be recognized that they will work on various jobs for, say, 50 weeks in the year but receive pay for 52 weeks. Unless industry conditions practically guarantee that vacations will not be deferred and that they will be spread evenly over the year, vacation time should not be treated as manufacturing overhead. Instead, it should be accrued. The **accrual of vacation time** should be charged as part of the labor cost and credited to a liability account, which is charged later when workers take their vacations.

Bonuses. Some wage plans provide workers with bonuses when they are engaged on assignments that require extra effort, are distasteful, or are hazardous. Certain work may be classified as dirty work for which there is an extra hourly bonus. Riggers may receive bonuses for time worked over a given height from ground level. Such bonuses are extra costs that are properly chargeable to the job that is responsible for them.

Overtime Premiums. Neuner (Cost Accounting: Principles and Practice) points out that some firms ". . . exclude all overtime premium payments from the cost of manufacturing . . ." He continues, "The obvious reason for this is that including it in one period of time and not including a similar cost when business is not so active results in costs which are not comparable and therefore not controllable." These firms exclude overtime premiums from inventory costs by charging them directly to **profit and loss.**

Other firms regard overtime premiums as **manufacturing costs,** but they do not follow a common procedure. Some charge the premiums to manufacturing overhead so that they are distributed over all work performed during the period of overtime. Others charge the premiums as part of the direct labor to the jobs worked on during overtime periods. The correct procedure seems to depend upon the nature of the overtime. If no single job is responsible for overtime, even though one is caught by chance in an overtime period, then fair treatment requires overtime to be charged to manufacturing overhead. On the other hand, if a job is individually responsible for overtime because of some reason such as a short delivery deadline known when the job was undertaken, then it is justifiable to charge the overtime to it.

Payroll Taxes. Federal Insurance Contributions Act taxes and unemployment taxes (both federal and state) are costs that are directly related to the employment of labor. The question is whether these costs should be classed as **direct labor costs** and charged to jobs as such or classed as **manufacturing overhead.** Blocker and Weltmer (Cost Accounting) say:

> . . . When a cost accounting system is employed, it is essential in obtaining accurate costs to apportion the payroll tax accounts to existing cost units or factors upon equitable distribution bases.
>
> In manufacturing concerns, the employer's payroll taxes and dues may be considered as indirect costs and charged first to Factory Overhead Control and then allocated to service and production departments. . . . The basis of the distribution is generally the proportionate wages and salaries earned by employees in each division.
>
> Some accountants recommend the practice of charging payroll taxes directly to appropriate wages and salaries accounts, but such a procedure is not advisable when cost methods require that labor costs be charged to production orders. Such a practice would require adjustment of workers' daily time cards from which charges may be made directly to production orders.

In addition to this cited difficulty of charging payroll taxes to wage accounts, there is a further mechanical problem that also tends to preclude such treatment. FICA taxes are levied on the first $4,800 of wages earned by an employee in a calendar year. Wages in excess of $4,800 are not subject to tax. This means that hourly labor charges will not be constants during a year. They will be higher in January than in December in the case of employees earning more than $4,800 a year from the same employer. Insofar as total costs (direct material, direct labor, and manufacturing overhead) are concerned, this particular difficulty is not avoided by charging payroll taxes to manufacturing overhead. If it is desired to

attempt to allocate these costs rateably over the entire year, however, adjustments can be handled more readily if the costs are part of manufacturing overhead.

Posting Labor Charges. When management requires cost data currently, labor charges are posted daily and in such detail as is necessary. Methods and procedures for posting labor charges are discussed in the section on Labor Costs.

MANUFACTURING OVERHEAD. This category includes all production costs that are not identifiable, either in fact or by choice, with specific jobs. These costs are applied to work in process by means of rates. Such rates may be calculated at the end of the month on the basis of **cost actually incurred,** or they may be predetermined on the basis of **estimated future costs** (see sections on Manufacturing Overhead and Product Cost, and Manufacturing Overload and Normal Activity). The latter method enables complete job costs to be available from day to day; the former makes it necessary to wait until the end of the month for such costs. Since rates serve the purpose of distributing manufacturing overhead to the various jobs, the factor upon which the rate is based (direct labor cost, direct labor hours, direct material cost, machine hours, etc.) must be selected carefully in order to ensure equitable distribution.

Departmentalization of Manufacturing Overhead. Manufacturing overhead may vary widely from one **department, or cost center,** to another. Since each job does not necessarily pass through every department, one **plant-wide rate** for manufacturing overhead may result in cost distortions. Consider a case where Job A passes through Departments Nos. 1 and 4, both of which are costly to operate. Job B passes through Departments Nos. 2 and 3, both of which are not costly to operate. Assuming that each job incurs $100 of direct labor cost, a single, plant-wide rate would cause each job to be charged the same overhead. Manifestly, Job A should be charged more overhead than Job B. To achieve this end, manufacturing overhead must be departmentalized, with different rates established for different departments. A forum on job order industries at the annual convention of the National Association of Accountants (NAA Bulletin, vol. 35) indicated three **kinds of departments:**

1. Production cost centers.
2. Departments in cost centers such as machine shops and maintenance departments with service production centers.
3. A series of artificial cost centers or hypothetical cost centers which were set up specifically to enable more intelligent distribution of costs.

On occasion, valid cost distributions may be achieved without departmentalization if the base selected for distribution is closely correlated with the **incidence of manufacturing overhead.** For example, one rate for the entire plant could suffice if based on, say, machine hours instead of direct labor cost. But, departmentalization serves another purpose. In job order industries, **cost control** depends heavily upon the allocation of manufacturing overhead to separate departments, with departmental foremen assigned the responsibility of keeping costs in line. Departmentalization is thus both an administrative control and an accounting technique.

Applying Manufacturing Overhead. A common characteristic of items that comprise manufacturing overhead is that they are not identifiable with specific jobs. In order to apply overhead to the individual jobs, a sound base for apportionment must be found. This base must be comprised of parts that are identifiable with individual jobs. Direct labor cost currently appears to predominate as

a base. For detailed explanations of the various methods of applying manufacturing overhead, see the section on Manufacturing Overhead and Product Cost.

DEFECTIVE WORK. Matz–Curry–Frank (Cost Accounting) recognize that the inherent nature of a job is an important consideration in accounting for defective work:

> As in the case of spoiled work, two methods of accounting for the added cost to perfect the defective work are appropriate, depending upon circumstances. If the defective units are clearly identified with a numbered job order and the defects are peculiar to the job, the cost to complete the defective units should be charged to the job. If the defects occur on more or less common commodities ordinarily made in the factory, where defective units occur irregularly and the lot or job actually in process at the time is accidental, then the added cost is properly charged to manufacturing expenses [i.e., manufacturing overhead].

Van Sickle (Cost Accounting), who supports **direct allocation** of defective work to the job to which it applies, states, "The cost of defective work and spoilage must be accounted for in such a manner that the monthly cost of it is not buried. To lose sight of the defective work cost means to have an uncontrolled cost item."

Regardless of the method used, **salvage value of defective work** is a recovery that should be credited to the account to which the defective work is charged.

VALUING INVENTORY OF WORK IN PROCESS. The value of work in process consists of direct material, direct labor, and manufacturing overhead accumulated to the stage of completion reached at the end of a period. When individual jobs run over a long period of time, however, contractors may wish to recognize income currently in order that periodic income measurement will not be distorted by the chance factor of completion time for various jobs. A method used is the **percentage-of-completion method,** about which the Committee on Accounting Procedure of the American Institute of Certified Public Accountants (Accounting Research Bulletin No. 45) states:

> The percentage-of-completion method recognizes income as work on a contract progresses. The committee recommends that the recognized income be that percentage of estimated total income either:
>
> (a) that incurred costs to date bear to estimated total costs after giving effect to estimates of costs to complete based upon most recent information, or
>
> (b) that may be indicated by such other measure of progress toward completion as may be appropriate having due regard to work performed.
>
> Costs as here used might exclude, especially during the early stages of a contract, all or a portion of the cost of such items as materials and subcontracts if it appears that such an exclusion would result in a more meaningful periodic allocation of income.
>
> Under this method current assets may include costs and recognized income not yet billed, with respect to certain contracts; and liabilities, in most cases current liabilities, may include billings in excess of costs and recognized income with respect to other contracts.

When this method is used, that portion of job costs for which revenue is recognized must be matched against revenues in the income statement instead of being carried as work in process.

A related procedure was discussed in a forum on job order industries at an annual convention of the National Association of Accountants (NAA Bulletin, vol. 37) as follows: "Moving on to another inventory problem in job order cost-

ing, the group discussed costing of an order at year-end when the job runs several years or at least over the year-end. One practice cited breaks up the original order into smaller lots and treats them as "individual orders, closing them out profit-wise with income." This procedure is described under Multiple Job Order Cost System in this section.

CHECKING ACCURACY OF COSTS. One of the problems in a job order cost system is to be sure that direct materials and direct labor charged to a given job are actually used on it. Enersen (NAA Bulletin, vol. 37) writes, ". . . production expeditors, in their enthusiasm to get their job done, would 'steal' parts which had been charged to one job and use them on the job they were expediting. They would then forget to initiate the paper-work to transfer costs." There are also cases where **unauthorized work** is performed and charged to an authorized job. A system which discloses these situations is desirable.

There is one system that polices costs reasonably well. It requires that careful **cost estimates** be made before any job is started. This is often done anyway in job order industries. Upon completion of each job, actual costs are compared with the estimates. All significant differences are investigated thoroughly. The system has great merit even when it turns out that the estimates were not sound. It keeps cost estimators on their toes, a desirable condition when prices are set on the basis of cost estimates.

FORM OF JOB ORDER COST SHEET. According to Blocker and Weltmer (Cost Accounting):

> The heart of the system is the production order or cost sheet which is used as a daily record of direct material, direct labor, and estimated factory overhead cost for each department or operation for the entire course of production. Control of detailed costs on production orders is maintained as goods proceed through the plant by means of controlling accounts in the general ledger, which summarize costs of products put into process, transferred to finished goods, and finally sold.

Job order cost sheets vary from ordinary ledger accounts to elaborate custom-made sheets. Where machine accounting is used, cost sheets may simply be punched cards. Two considerations control the **cost sheet design.**

The first recognizes that the purpose of computing job costs is to provide cost data for the use of management. The amount of detail that is required determines the simplicity or elaborateness of the cost sheet. For example, if management wants costs in terms of direct material, direct labor, and manufacturing overhead, the cost sheet will have columns for each category.

The second depends upon how manufacturing overhead is charged to jobs. If it is departmentalized and charged to jobs on the basis of direct labor in each department, then the cost sheet must show the amount of direct labor separately for each department through which jobs pass. Fig. 6 illustrates a cost sheet that was designed with this in mind.

The job order cost sheets constitute the subsidiary accounts for the control account in the general ledger representing unfinished jobs. In the problem illustrated earlier in this section, there was only one work-in-process account in the general ledger. At the end of the month, after all postings had been made, it had a balance of $162,500, which was the sum of the costs accumulated to date on the three jobs still in process. In some cases a company prefers, in the interest of greater control, to use three **work-in-process accounts,** one for each of the three elements of manufacturing cost: materials in process, labor in process, and burden in process (or manufacturing overhead in process) (see flow chart, Fig.

Job Order Cost Sheet					Job Order No.______ Date Completed______		
Date	Dept. A	Dept. B	Dept. C	Dept. D	Dept. E	Dept. F	Total
Direct Materials							
	$	$	$	$	$	$	$
Direct Labor							
Manufacturing Overhead							
Totals	$	$	$	$	$	$	$
Units Produced				Estimated Cost			$
Unit Cost			$	Variance from Estimate			$

Fig. 6. Job order cost sheet.

1). Each of these three accounts will be charged with the amount of its cost applied to production during a period, rather than having all three elements of cost charged to a single work-in-process account. When a job is finished, each of the three in-process accounts will be credited with the amount of its cost shown on the cost sheet of the job completed. A corresponding debit is made to the finished goods account. At the end of each fiscal period, the balance in the materials-in-process account should be equal to the sum of the direct material on the cost sheets of jobs still unfinished. The labor-in-process and burden-in-process accounts would be "proved" in similar fashion.

CENTRALIZATION OR DECENTRALIZATION. Job order cost systems may be organized on either a centralized or a decentralized basis. A **centralized system** is one in which cost sheets are maintained in the accounting department. A **decentralized system** is one in which cost sheets accompany jobs through the plant.

With respect to **centralized systems**, Blocker and Weltmer (Cost Accounting) state:

> . . . The production order for each job is retained in the cost accounting department. . . . Copies of material requisitions and of time tickets or wage reports, bearing production-order numbers and representing work done for each day or week, are sent to the cost department to be used as the basis for charges for direct material and direct labor to production orders.

As for **decentralized systems**, Blocker and Weltmer say:

> . . . The supervisor, foreman, timekeeper, or cost clerk in the department is responsible for recording cost information in the production order. Materials requisitions are used as the basis for charging material costs to the order; time tickets and piece-rate reports are records from which labor hours and labor costs are obtained; and a predetermined rate per hour of direct labor, machine-hour, or dollar of direct labor cost is given to the department as the basis for the application of factory overhead to each order.

Modifications of Job Order Cost Systems

MULTIPLE JOB ORDER COST SYSTEM. The job order cost system is often modified in the case of **contractors**, especially those handling large jobs that continue for fairly long periods of time. The normal job order cost system is inadequate because one job cost sheet simply does not provide adequate analysis to measure and control costs during the period of construction. To overcome this deficiency, a multiple job order cost system is utilized.

The essence of a multiple job order cost system is the recognition that most large jobs can be subdivided into numerous **individual components.** Instead of one job order number being assigned to the work, a separate job order number is assigned to each component. By careful **indexing** or **coding of job order numbers,** individual job identities are preserved. As work progresses on each component of a job, accomplishment and accumulated cost to date are measured against cost estimates for the work. Thus cost control is established on a basis that would not be possible if all costs were lumped on one cost sheet.

CLASS COST SYSTEM. In some companies that have a large number of products, individual products may be quite similar. Rather than maintain separate job cost sheets for each product, costs of producing similar products are grouped on one cost sheet, a **class cost sheet.** The purpose in doing this is to

reduce clerical detail and cost. The procedure is justified when reasonable and reliable costs result. Sometimes referred to as **product costing,** *this class costing* is related to both job order and process costs.

Devine (Cost Accounting and Analysis) explains the basic **principles of a class cost system** as follows:

> . . . For example, a foundry may have 300 different castings produced during a given interval. Instead of tracing direct costs and assigning indirect costs to each of these castings through the medium of separate cost sheets or separate accounts, the accountant may group the 300 items into, say, 20 classes or groups and trace costs by job order methods only to these classes. There is, of course, a further problem; the products within each group are not homogeneous. Sometimes it is assumed that the diverse castings within a class have identical costs, so that the unit cost of each class is found by dividing the entire class cost by the number of units completed within the group. In some cases this crude method of finding unit costs for entire classes needs refinement. One approach is to use weights or points for the breakdown of total class costs to the class constituents. For example, a foundry may set up separate classes for each shape of casting with a given kind of core and disregard physical weight entirely for class grouping Thus, all castings of a certain shape with particular cores may be grouped together. For purposes of unit cost determination the class cost may be divided among the castings of different sizes according to points assigned to each. It should be obvious that alternative methods of grouping are available. It may be more convenient, for example, to have different classes corresponding to castings of different size and to use points to spread the class cost among those having no cores, ordinary cores, or other differences.

ASSEMBLY COST SYSTEM. Some manufacturing operations involve first the **production of a variety of parts** and then the **assembly of appropriate parts** into various units of finished product. In discussing an assembly cost system, Gillespie (Cost Accounting and Control) says:

> . . . there are parts cost sheets and assembly cost sheets. The former are used to compile the cost of parts. In an automobile plant, there would be parts cost sheets for wheels, frames, axles, and all other parts manufactured by the company. A parts cost sheet would be used to compile the cost of materials, labor, and factory expense chargeable to a specified quantity of a particular part
>
> Assembly cost sheets would be used to compile the cost of the finished assembly They show the costs of the parts and the cost of the labor and expense required to assemble the parts.

The assembly cost system derives its name more from the recognition of manufacturing characteristics than from the fact that the accounting procedures are very different from those employed in an ordinary job order cost system. Costs of parts which are produced for stock can be accumulated on ordinary job cost sheets and transferred to **stores cards** when the parts are completed. Costs of assembling finished products can also be accumulated on similar job cost sheets, especially if the sheets are designed flexibly. **Separate cost sheets for** parts and assemblies, instead of one multi-purpose cost sheet, are sometimes employed merely to identify the two types of work.

IMPACT OF DIRECT COSTING. When direct costing is employed instead of **absorption costing,** the methods and procedures of a job order cost system undergo little change. The impact falls entirely on manufacturing overhead. **Variable manufacturing overhead costs** must be segregated so that they can be charged to work in process and appropriate job cost sheets. If there are no significant, variable elements of manufacturing cost, job cost sheets contain charges

for direct material and direct labor only. Direct costing is discussed in the section on Manufacturing Overhead and Product Cost.

STANDARD COSTS IN A JOB ORDER COST SYSTEM. Standard costs can be used in a job order plant as well as in a process plant. The existence of standard costs will greatly facilitate the preparation of cost estimates on individual jobs. Acker (NAA Bulletin, vol. 30) supports this in the statement, "We are one company—and there are an increasing number—which makes use of standard costs in connection with a job costing system. There are two main reasons for having standard costs: as a measurement of performance and for accounting convenience." Keller (Management Accounting for Profit Control) explains:

. . . Regardless of the type of manufacturing plant, a number of operations are performed on one or more materials. The development of standard costs for individual orders, each of which uses only some of the operations and may have a different production sequence from the others, is no more difficult than it is for developing standard costs for products which pass through all of the operations and always in the same sequence. True, more standards must be built, but these also are needed for price determination and for scheduling production. In filling these latter needs, all the other requirements of standards for cost control are also met.

COMBINED JOB ORDER AND PROCESS COST ACCOUNTING. Since an accounting system should fit a business, it is appropriate to use **job order** cost accounting in connection with some manufacturing operations and **process cost** accounting in connection with others. Schlatter and Schlatter (Cost Accounting) illustrate this as follows:

As an example of the use of two methods at the same time in one plant the practice of a pottery plant is cited. The particular pottery of the example makes all its products from the one kind of clay available in its own quarries. From the quarry, clay is mined continuously. There is no variety in its product Therefore, the accounting for the quarry can best be operated on the process-cost method. In another department, the clay is cleaned, ground, mixed with water to the proper consistency, and otherwise made ready for the forming, or molding, operations. Because all types of pottery made by this plant use the same uniform mix, the operations of preparation are continuous processes, and the accounts for the mixing department are operated on the process-cost method.

In the forming department the situation is different. At this point begins the differentiation of product into flowerpots, kitchenware, novelties, etc., each of many sizes and shapes. The quantity of each variety or size is too small to permit continuous specialized line production, and, therefore, the work must be put through in lots. Because the work is done by lots, job cost accounting is required in this department.

Reports

MONTHLY GROSS PROFIT ANALYSIS BY COMPLETED JOBS. Managements of many companies find that a periodic review of operations is helpful in evaluating past performance. Since the margin between selling price and production cost is a significant factor in the determination of final profit (or loss), a **monthly summary of gross profit** by individual jobs may be prepared, as illustrated in Fig. 7.

This report can easily be expanded to provide additional desired information. When **job code numbers** are not set up to indicate characteristics of individual jobs, a column may be added for **job descriptions**. Starting and completing

dates may be useful additions. A column for indicating the percentage of gross profit to sales price may be helpful to some readers, along with explanatory notes when the percentage appears to be unusual. The single column for manufacturing cost may be supplemented by three columns (one each for direct material, direct labor, and manufacturing overhead), but it is questionable whether this detail is desirable on a **summary tabulation.** If questions arise in connection with some jobs, they may better be answered by reference to individual job reports. Consideration may also be given to whether a column for **estimated job costs** would be a helpful addition.

SAXTON MANUFACTURING COMPANY

GROSS PROFIT ANALYSIS BY COMPLETED JOBS

For the Month of ________

Job. No.	Manufacturing Cost	Sales Price	Gross Profit
16–2341	$ 612	$ 1,050	$ 438
16–2342	428	980	552
16–2344	719	1,425	706
17–0927	2,970	3,500	530
17–0928	1,643	3,200	1,557
27–4695	317	575	258
Totals	$93,118	$174,365	$81,247

Fig. 7. Analysis of gross profit by completed jobs.

COMPLETED JOB REPORTS. In companies where costs are checked for accuracy in the manner described earlier, a report on each completed job must be submitted to the person, or persons, designated to investigate significant differences between actual costs and estimated costs. Such a report is illustrated by Fig. 8. The responsible authority, upon receipt of a completed job report, must determine whether differences between actual and estimated costs should be investigated. Investigations are as important when actual cost is less than estimated cost as when actual cost is greater than estimated cost. On occasion it may be wise to spot-check when there are not significant differences.

ANALYSIS OF COST VARIANCES. When actual costs differ from estimated costs, the difference is due to the fact that one, or all three, of the cost elements—direct material, direct labor, or manufacturing overhead—is out of line. For any single element, the difference may be both or one of two factors: (1) **cost of units used,** or (2) **quantity of units used.** Hence, separate **cost variances** can be computed as follows:

1. **Material cost variance.** Multiply the actual quantity of materials used by the difference between actual price per unit and estimated cost per unit.
2. **Material quantity variance.** Multiply the estimated cost per unit by the difference between actual quantity and estimated quantity.
3. **Labor rate variance.** Multiply actual hours by the difference between actual rate per hour and estimated rate per hour.
4. **Labor efficiency variance.** Multiply estimated rate per hour by the difference between actual hours and estimated hours.

Separate variances can be figured for manufacturing overhead in similar fashion, but such computations have little significance when manufacturing overhead is applied to jobs on the basis of direct labor cost (the most prevalent way). Variances in direct labor cost then automatically introduce variances in manufacturing overhead.

Saxton Manufacturing Company Job No. 16-2344

Completed Job Report Started 1/7/- Completed 1/10/-

Cost Element	Actual Cost	Estimated Cost	Difference ( ) Unfavorable
Material	$ 270.67	$ 271.50	$ .83
Labor	213.54	210.00	(3.54)
Manufacturing Overhead	234.89	231 00	(3.89)
Total	$ 719.10	$ 712.50	$ (6.60)
Sales Price	$ 1425.00	Investigate difference? No	
Gross Profit	$ 705.90	C. C. Brown	

If difference investigated, report findings

Fig. 8. Completed job report.

Since analysis in terms of basic variances for the difference between actual cost and estimated cost may be useful in investigating the reasons for the difference, a **job variance analysis** (Fig. 9) may be prepared. The variances in Fig. 9 are computed in the following manner: The actual cost of Fabric No. 409 was the product of 110 yards at $1.10 per yard. Estimated cost was the product of 100 yards at $1.00 per yard. The **material cost variance** is 110 yards multiplied by $0.10 per yard, or $11.00. The **material quantity variance** is $1.00 multiplied by 10 yards, or $10.00. The actual labor cost in Department No. 1 was the product of 77 hours at $2.05 per hour; estimated cost was the product of 75 hours at $2.00 per hour. The **labor rate variance** is 77 hours multiplied by $0.05 per hour, or $385. The **labor efficiency variance** is $2.00 multiplied by 2 hours, or $4.00. Labor variances for Department No. 2 have been computed in the same fashion.

Saxton Manufacturing Company **Job No.** 17- 1034

Job Variance Analysis **Date Completed** 1/18/—

Cost Element	Actual Cost	Estimated Cost	Difference	Variance Due to: Cost	Variance Due to: Quantity
Material:					
Fabric #409	$ 121.00	$ 100.00	$ (21.00)	$(11.00)	$ (10.00)
Labor:					
Dept. No. 1	157.85	150.00	(7.85)	(3.85)	(4.00)
Dept. No. 2	264.00	244.00	(20.00)	—	(20.00)
Dept. No. 3					
Dept. No. 4					
Manufacturing Overhead	464.04	433.40	(30.64)	XXXX	XXXX
Totals	$1,006.89	$ 927.40	$ (79.49)	XXXX	XXXX

( ) Denotes unfavorable variance

Fig. 9. Job variance analysis.

DEFECTIVE WORK REPORTS. Such reports advise management of the losses from **defective work** and also serve to minimize such loss because of the fact that it is reported. Defective work reports may be made **separately** for each instance of spoilage, or **periodically**—daily, weekly, or monthly—in a system of reporting that combines individual reports with periodic summaries. This is discussed further in the section on Materials under Scrap.

OTHER REPORTS. The foregoing reports are but a few of the financial reports that are used in a job order business. They are reports that are distinctive of job order accounting. The characteristic of job order accounting is the manner in which costs are accumulated by jobs. Thus the reports peculiar to job order accounting are limited largely to those prepared from **job cost sheets.** For a further discussion of the preparation and use of cost reports, see the section on Cost Control, Budgets, and Reports.

Departmental cost statements, although not peculiar to job order cost systems, merit special attention. Adequate administrative control over manufacturing overhead requires that cost statements be prepared for all departments in a plant. Control can only be instituted if cost statements are prepared for each department and if departmental foremen are held accountable for the costs of their departments. The analysis that develops such data is covered in the section on Cost Control, Budgets, and Reports.

Evaluation of Job Order Costing

ADVANTAGES. The principal advantage of a job order cost system is that it compiles cost data in the manner that is most useful in the administration of certain kinds of businesses. Kemp (NAA Bulletin, vol. 38) states:

> . . . To be useful, a cost system must be flexible and must provide accurate cost data very soon after the expenditure is incurred, and in usable form. Needless to say, the cost of obtaining this information must be in proper proportion to its relative worth. The job order cost system has thus far best served the requirements of our business. Over the years many changes have been made in our system in order to reduce the cost of obtaining the individual job costs on all orders and, at the same time, provide adequate information.

Lang–McFarland–Schiff (Cost Accounting) list the following specific advantages:

1. Ability to detect which jobs are **profitable,** which unprofitable.
2. Use of job costs as a basis for **estimating similar work** in the future.
3. Use of job costs as a basis for **controlling efficiency** of operations.
4. Use of job costs on **government contracts** and other contracts where cost determines selling price.

The authors warn, however, that the second advantage listed can be used only within limits. Care must be taken to evaluate any discrepancies in cost that might arise because of the lapse in time between completion of the old job and the new one being estimated, and because of differences in the size of the order.

DISADVANTAGES. The main disadvantage of a job order cost system is that it is expensive to operate because it involves considerable detailed clerical work. Direct labor provides a good illustration. Thirty men in one department could each work on twenty different jobs in one payroll period, thus necessitating up to six hundred separate postings to job cost sheets. In a process cost system, one summary posting for the same period of time to a process cost sheet can take care of any number of men assigned to a given department.

Schlatter and Schlatter (Cost Accounting) discuss criticisms of job order accounting. They say that the system is expensive to operate and that it offers opportunity for errors. They point out that production personnel may spend time on clerical work at the expense of productive work. They state that ". . . little information for managerial control is to be gained from job cost reports." Although these are but some of the criticisms they make, their validity is supported by Enersen (NAA Bulletin, vol. 37) who writes, "For several years we tried to handle our situation with a job cost system, but it gradually became more and more unwieldly, even with a relatively small volume of business."

Job order cost systems should be used only in situations where they are needed. They should be developed, periodically evaluated, and refined so that the difficulties involved in using them can be minimized.

SECTION 12

PROCESS COST SYSTEMS

CONTENTS

SECTION 12

PROCESS COST SYSTEMS

Definition and Characteristics

DEFINITION OF PROCESS COSTS. Process costing represents a type of cost procedure for continuous or mass production industries. In such industries output consists of like units, each unit being processed in the same manner. Therefore it is assumed that the same amount of materials, labor, and overhead is chargeable to each unit processed. The cost of a unit at the end of any manufacturing process can be readily determined, provided costs are accumulated on a process basis and a record of units produced is available.

Unlike **job order costing**, where costs are recorded separately for each job or order going through the plant, the emphasis in **process costing** is on the accumulation of costs for all units worked on in a department during a given period of time. The units processed in a department typically are homogeneous in nature, and average costs are computed to determine the basis for transferring costs from one department to the next processing center.

Gillespie (Cost Accounting and Control) states:

> A process cost system is used where it is not possible or not desirable to identify the successive jobs or lots of production for cost accumulating purposes. In a process cost system, costs and production units are accumulated period by period. At the end of each period (often one month) cost per unit of goods produced is determined as an average unit cost for the period.

Thus, the **conditions for use** of process costs are:

1. Continuous or mass production.
2. Loss of identity of individual items or lots.
3. Complete standardization of product and processes.

CHARACTERISTICS OF PROCESS COSTS. An understanding of process costs is facilitated when they are discussed against the background of job order costs, where the materials, labor, and manufacturing overhead are accumulated, and unit costs are not available until the job is completed.

In process costs the emphasis is on **period of time** and **number of units** completed. Products usually are manufactured for stock rather than for specific orders. Unless the **production cycle** is less than one day, there usually will be work-in-process inventory at the close of an accounting period.

Blocker and Weltmer (Cost Accounting) list five conditions which are favorable for the use of process cost accounting principles:

1. Production of a single product in a plant.
2. Division of a plant into processes or departments, each responsible for the manufacture of a single product.

3. Processing of a single product for a scheduled time, followed by successive runs of other products, each run being separated as to production and costs.
4. Production of several products of standard design in the same plant, process, or department under conditions which permit computation of weighted averages to denote relative importance of each product as to quantities and costs.
5. Division of a factory into separate operation or production centers, each performing standard operations.

GENERAL PRINCIPLES. The following statement by Blocker and Weltmer (Cost Accounting) of the general principles or basic ideas underlying process costs assists in distinguishing them from other cost systems:

1. Costs, both direct and indirect, are accumulated in cost accounts during the period and are reclassified by departments or processes at the end of the period
2. Production in terms of quantities such as units, tons, pounds, feet, and gallons are recorded by processes daily or weekly and are summarized in departmental reports at the end of the period.
3. The total cost of each process is divided by the total production for the process, to obtain an average cost per unit for the period.
4. When products remain in process at the end of a period, production and inventories are computed in terms of completed products, the stage of completion usually being estimated and the identity of each lot being ignored.
5. If units are lost or spoiled in a department, the loss is borne by the units completed and remaining within the department, thus increasing the average cost per unit.
6. In cases where products are processed in more than one department, costs of one department are transferred to the next department, the total cost and unit cost of products being accumulated when completed.

EVALUATION OF PROCESS COSTING. The chief **advantages** of process costing are:

1. Costs are computed periodically, usually at the end of the month only.
2. Average costs are computed easily, provided the product is homogeneous.
3. Less clerical effort and expense are involved than in job order costing.

As opposed to these, the **disadvantages** of process costing are:

1. Where historical process costs are used, they are not determined until the end of the cost period. This has a tendency to delay statement preparation.
2. Average costs are not always accurate because the units are not fully homogeneous. For example, the computation of costs of castings in a foundry on a weight basis may not be accurate because the weight factor may not reflect the relative difficulty of making the different castings.
3. Where different products are manufactured, the proration of cost elements is necessary, and the computation of average costs is made more difficult.
4. Inaccuracies in unit costs are reflected in inventory values of work in process, finished goods, and cost of sales, especially where it is often necessary in computing unit costs to take into account the stage of completion of the closing inventories. This must usually be estimated, thus further weakening the accuracy of unit cost figures.
5. Where process costs are used on an actual basis only, the system shares all the disadvantages of any actual cost scheme. By the very nature of process cost accounting as an averaging method, management may overlook inefficiencies in operations unless great care is exercised in isolating these inefficiency factors through the use of standards supplementary to process costs.

Blocker and Weltmer (Cost Accounting) have summarized the **managerial benefits** which they believe can be obtained from a complete system of process costs. In making this comparison, they assume that process cost systems incor-

porate budgets for overhead costs, maintain service departments and operations as costing units, and employ predetermined application rates:

1. The cost plan produces an average cost per unit of completed products with detailed costs for materials, labor, and overhead computed for each process or operation.
2. The unit costs are available at the close of each accounting period, which is generally a month, but in some plants where predetermined overhead rates are employed, unit costs are available at the close of each day or week.
3. The costs of operating the system are much less than is required for the job order cost plan, since it is more economical to classify and summarize costs by processes or operations than for each job.
4. Monthly reports make possible reliable comparisons between budgeted and actual costs for each product by processes or operations, thereby permitting the extension of managerial control to include the evaluation of operating efficiency.

The following summary of the **weaknesses of process costs accounting** from the managerial point of view is also given by Blocker and Weltmer (Cost Accounting):

1. It produces an average cost per unit for the accounting period, but an average cost figure may be considered unsatisfactory inasmuch as it prevents a detailed analysis and evaluation of the operating efficiency of individual workmen, departments, and operations on a daily basis.
2. Costs are reported on a historical basis, and the reports of operational costs are available to management for a post-mortem examination only, too late to permit the exercise of the most effective managerial control.
3. The attention of management is directed toward actual costs, which may include excessive quantities of materials, spoiled work, ineffective use of labor, and unnecessary overhead costs rather than what costs should be, assuming that the plant has reached a high point of operating efficiency. The incorporation of standard costs is an essential improvement because of the change in the point of view of management that generally results.

COMPARISON OF JOB ORDER AND PROCESS SYSTEMS. In some plants process costs are used in certain departments and job order costs in others. Vance (Theory and Technique of Cost Accounting) points out that for products going through both types of departments in such a plant, **job cost sheets** are used, and the costs are recorded by job order methods except for the process cost departments, where **unit costs** are determined and are then recorded on the job cost sheets in the proper amount for each job.

Management does not have a free choice in the selection of the cost system for a department. The solution is dictated to a considerable degree by the nature of the products and the methods of producing them. Fig. 1 compares the job order and process cost systems on the basis of these factors. (See section on Job Order Cost Systems for a detailed treatment of such systems.) **Standard costs** or **estimated costs** may be applied with either job order or process cost systems. (See sections on these types of costs.)

CLASSIFICATION OF PROCESS COST MANUFACTURERS. Manufacturers using process costs may be classified as follows:

1. Production of a single product.
2. Production of a variety of products using the same productive facilities.
3. Production of a variety of products using separate facilities; i.e., a separate plant for each product.

	Job Order	Process
PRODUCTION	1. By specific orders. 2. On customer's specifications.	1. Continuous flow. 2. Homogeneous product. 3. For stock.
COSTS	1. Determined by job orders. 2. Prime costs and burden segregated in accounts. 3. Calculated when job finished.	1. Determined by units of product. 2. For each department or process. 3. Calculated at end of cost period. 4. Transfer of costs from process to process.

Fig. 1. Job order and process methods compared.

Examples in the first group are found in the manufacture of such products as ice, cement, beer, and sugar. The second group may be illustrated by the manufacture of various chemicals from the same production facilities, different types of brick, tile, ceramic products, and others. The third group resembles the first group, since each plant manufactures but one product.

According to Matz–Curry–Frank (Cost Accounting):

Process costing methods are applied to different types of industries such as chemicals, petroleum, textile, steel, rubber, cement, flour, sugar, and coal. This type of costing is also used in firms making articles such as rivets, screws, bolts, and small electrical parts. A third type of industry using process costing methods is the assembly-type industry which manufactures household electric appliances (washing machines, refrigerators, toasters, electric irons, radios and television sets), typewriters, automobiles, and airplanes. Finally, certain service industries such as gas, water, electric power, and heat will cost their products by the process cost method.

MAJOR PROCESS COST SYSTEMS. Vance (Theory and Technique of Cost Accounting) describes three major process cost methods: (1) sequential, (2) parallel, and (3) selective process costs. He labels as **sequential process costs** those that appear where all product goes through a series of processes in sequence. The costs are transferred from one process account to another as the product is transferred, with the cost of finished product being transferred from the last process account to Finished Goods (Fig. 2). He states:

This method is used by concerns making a single uniform product or products that get uniform processing. It is used by, or is the basis for cost calculations of, manufacturers of bread, refined ores and metals, sugar, beverages, portland cement, leather, patent medicines, and many chemical products, to name only a few.

Vance describes **parallel process costs** as those used where two or more products go through two or more separate sets of processes (Fig. 3):

The different sets of processes may be carried on simultaneously, or one set may be run for a while and then another started. Simultaneous parallel processes are illustrated by many concerns that break down a natural product—the analytical industries. . . . Nonsimultaneous parallel processes are illustrated by the fruit and vegetable canning industry. In most canneries one fruit or vegetable will be processed for a period and then another will be processed.

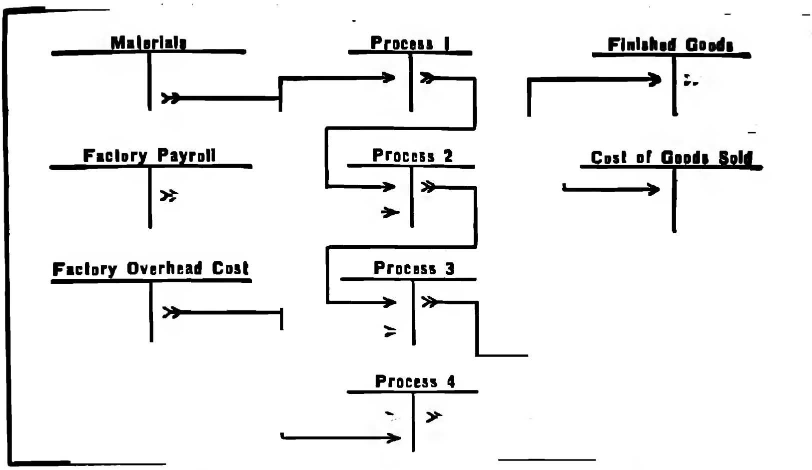


Fig. 2. Diagram for sequential process costs.

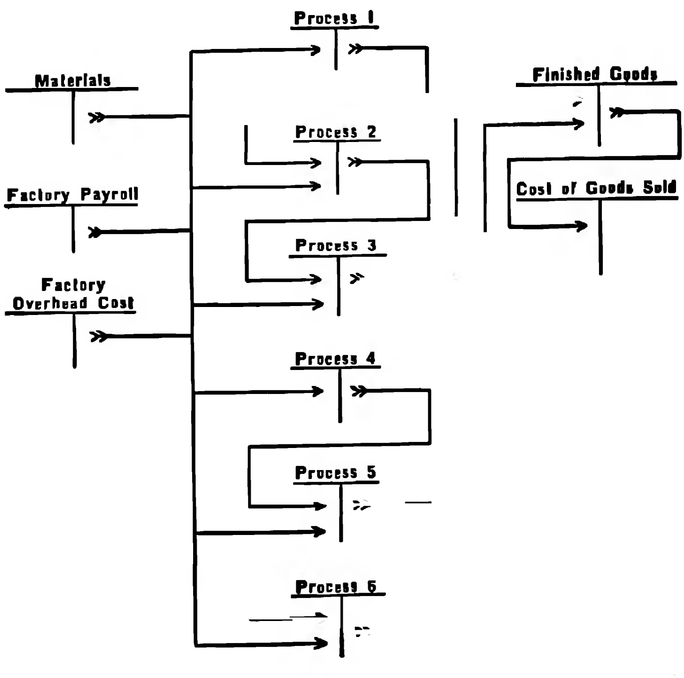


Fig. 3. Diagram for parallel process costs.

Vance distinguishes **selective process costs** as those accumulated from various processes for various products (Fig. 4):

They are used where products go through some but not all processing steps, the processing used varying for different products. For example, in a meat-packing plant, all products start in the cutting process, bacon and hams go through a "smoke" curing process, some meats are cured in brine (as salt pork and corned beef), some are frozen, some canned, some packed in paper, while others are shipped without packages.

Vance shows the flow of costs through the general ledger accounts for each of these three process cost methods in Figs. 2, 3, and 4.

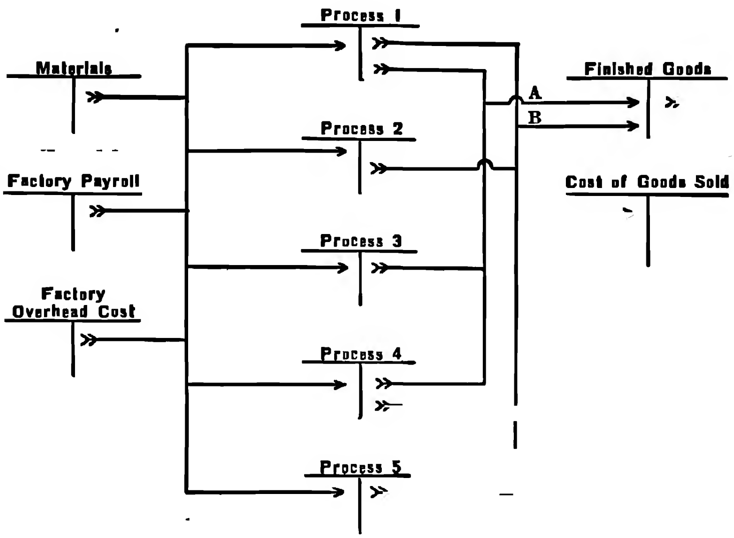


Fig. 4. Diagram for selective process costs.

DEPARTMENTALIZATION OF OPERATIONS. Very few companies produce a single product requiring only one manufacturing process. Even the production of a single product may require many processes. Whenever more than one process is used in the production of one or more products, or where more than one product is being produced, it is necessary for the proper allocation and control of costs to subdivide the production activities into **departments, cost centers,** or **processes.**

Kohler (A Dictionary for Accountants) defines a department as "A cost center, operating unit, or area; a function; an activity." A cost center is defined as "A division, a department or subdivision thereof, a group of machines or of men, or of both; a single machine and its operating force, or any other unit of activity into which a manufacturing plant and its operations are divided for purposes of cost assignment and allocation."

Blocker and Weltmer (Cost Accounting) recognize the importance of proper classification of production activities and make no distinction between a depart-

ment and a process. They do, however, distinguish a cost center from a department or process: "The factory may be divided into processes which include relatively large spheres of activity, or into operations or 'cost centers' which are limited to a single operation or type of work."

Although a process or department may include several operations, the most important characteristic for cost control is that one supervisor is responsible for the department. Similarity of operations and physical location of the men and machines will determine the size of the department.

Service departments are necessary under process cost systems just as they are for other cost systems. The costs incurred by the service departments must be distributed to the various producing departments before unit costs can be determined.

Process Cost Procedure

PROCESS PRODUCTION ORDERS. Where production is continuous, special production orders are not required. This is the case in ice plants, mining, quarrying, steam plants, etc. This involves planning of the work so that continuity of production is maintained. Starting with the sales budget and making allowance for seasonal variations, returns, inventories, etc., **production quotas** are set by months or other convenient time interval. Notice of these quotas is given to the production control section, which in turn transmits them to the producing centers. Where several products are manufactured, orders must be planned and issued much as in job order plants.

FUNCTIONS OF PROCESS COSTING. The purpose of process costing is to accomplish the following ends:

1. To accumulate and distribute service department expenses.
2. To compute unit conversion cost for each process at the end of each cost period.
3. To transfer costs from process to process. To do this it is necessary to
   a. Price transferred product.
   b. Place a value on inventory of work still remaining in process.

Blocker and Weltmer (Cost Accounting) show the following formula for determining **unit conversion cost:**

$$\frac{\text{Total cost of material, labor, and factory overhead for each process for the accounting period}}{\text{Total production in common unit for each process for accounting period}} = \text{average unit cost for each process}$$

For management purposes it is not sufficient to have one average unit cost for each process; unit costs are essential for each element of cost. For each element of cost it is necessary not only to accumulate its total cost but also to maintain appropriate production records which are used in the determination of unit costs.

PROCESS COST ACCOUNTING PROCEDURES. Neuner (Cost Accounting) emphasizes that process costs are **average costs** (daily, weekly, or monthly) and stresses certain procedures:

1. Instead of accumulating materials, labor, and overhead costs by job order, they are accumulated and recorded by departments or processes.
2. As already stated, costs are recorded on a time basis rather than on a job basis.
3. Costs are summarized on a cost of production report which includes the cost of materials, labor, and manufacturing overhead for a definite period of time on a departmental basis.

Any one of several forms may be used for the **cost of production report.** In each case certain information is essential:

1. Production costs are analyzed. The report should include costs incurred within the department as well as costs transferred from preceding departments. All costs must be accounted for: transferred to next department or to finished goods; work in process within the department; lost or spoiled.
2. The report should also include the data on units of production: units received from other departments; units started in process; units transferred to next departments or to stockroom; units lost or spoiled or otherwise disposed of.

Blocker and Weltmer (Cost Accounting) give an example of a cost production report in Fig. 5.

	Process 1		Process 2		Totals	
	Cost put into process	Cost per unit	Cost put into process	Cost per unit	Cost put into all processes	Accumulated cost per unit
A. Costs of production						
Cost from previous processes.........			$60,000.00	$1.20		
Cost added in present process						
Materials.........	$25,000.00	$0.50	---	---	$25,000.00	$0.50
Labor.............	12,500.00	0.25	7,500.00	0.15	20,000.00	0.40
Factory overhead..	22,500.00	0.45	12,500.00	0.25	35,000.00	0.70
Total cost put into each process......	$60,000.00	$1.20	$20,000.00	$0.40		
Accumulated costs............	$60,000.00	$1.20	$80,000.00	$1.60	$80,000.00	$1.60
B. Units of production						
Received in process..	50,000		50,000			
Completed and transferred.......	50,000		50,000		50,000	
Production divisor in terms of completed units..............	50,000		50,000			
C. Costs of production apportioned to units of production; materials, labor, and factory overhead..........	(50,000@$1.20)	$60,000.00	(50,000@$1.60)	$80,000.00	50,000@$1.60	$80,000.00

Fig. 5. Cost production report for a single product completed in two processes.

OPERATION OF PROCESS ACCOUNTS. Costs for materials, labor, and manufacturing overhead are charged to the usual accounts as incurred, analyzed by processes, and distributed by appropriate journal entries to process accounts. Production figures are reported daily by processes and are accumulated for the entire cost period. For purposes of computation by the cost accounting department at the end of the month, a **record of production** must show the following information relative to quantities:

1. Finished product on hand at beginning of period.
2. Goods still in process at beginning of period and their stage of completion expressed in percentage form.
3. Quantity received from preceding process.
4. Quantity delivered to next succeeding process.

5. Finished product on hand in process at end of period.
6. Goods still in process at end of period and stage of completion.

On the basis of production and figures in the process accounts, the cost department computes **average unit costs** and prepares **journal vouchers** to cost the production transferred to next process and the inventory on hand in each process.

RECORDING PROCESS COSTS. Costs may be recorded in process accounts by any one of the following methods:

1. Use of a single work-in-process control account.
2. Use of a separate work-in-process account for each process; i.e., departmental work in process accounts.
3. Use of a work-in-process account for each element of cost: materials, labor, overhead.
4. Use of a work-in-process account for each product, with further subdivision for each product in each department, or by elements for each product, etc.

Single Work-in-Process Accounts. The degree of subdivision of the cost accounts varies with the complexity of the manufacturing operations. A single work-in-process account may be used advantageously in plants producing a single product. Examples include ice plants, blast furnaces, tanneries, and steam plants. Many such plants operate continuously and do not have any closing inventories. It is merely necessary to assemble figures for materials, labor, and overhead in a work-in-process account and divide the total by the figures shown in the production report to arrive at the average unit cost.

Where many processes are involved, it may be advisable to use a single work-in-process account as a **control account** and support it by individual process accounts in a subsidiary **process ledger.** This is analogous to a job order system where work-in-process is supported by a file of active cost sheets. In process costing, the control account is supported by a process ledger containing accounts for individual processes.

Multiple Work-in-Process Accounts. As in all modern accounting for larger companies, if process costs are wanted in considerable detail and in many subdivisions, **electronic data processing** should be considered; or as a minimum, the information could be obtained from punched card equipment. (For a discussion of the essentials of electronic data processing, see section on Basic Cost Records.) Use of such equipment makes possible the preparation of **production cost analyses** by:

1. Total costs.
2. Elements of cost.
3. Departments or processes.
4. Products.

Entries for Departmental Transfers. Neuner (Cost Accounting) points out that most work-in-process cost accounting consists of mathematical computations. He summarizes the few accounting entries required for **departmental transfers** as follows:

(1)

Work in Process, Dept I
    Stores Control
    Payroll
    Manufacturing Overhead Control
To record cost of materials, labor, and overhead used in Dept. I during month.

(2)

Work in Process, Dept. II
    Work in Process, Dept. I
To record cost of work transferred to Dept. II from Dept. I.

(3)

Work in Process, Dept. II
    Payroll
    Manufacturing Overhead Control
To record costs incurred in Dept. II during month.

(4)

Work in Process, Dept. III
    Work in Process, Dept. II
    Payroll
    Manufacturing Overhead Control
To record the transfer and the departmental cost for Dept. III during month.

(5)

Finished Goods
    Work in Process, Dept. III
To record cost of work completed and sent to finished goods stockroom.

The balances of the departmental work-in-process accounts represent inventory of work completed but not transferred to next department, plus work not yet completed.

Accounts by Cost Elements. Depending on the requirements of managerial control, work-in-process accounts can be maintained by **elements of cost** rather than by departments, in which case the accounting entries in journal form would be:

(1)

Materials in Process
Labor in Process
Overhead Work in Process
    Stores Control
    Payroll
    Manufacturing Overhead Control
To record cost of materials, labor, and overhead used in Dept. I during month.

(2)

Finished Goods
    Materials in Process
    Labor in Process
    Overhead Work in Process
To record cost of work completed and sent to finished goods stockroom.

In a plant producing a widely varying line of commodities, the nature of the operations for each commodity produced often varies widely. It would be impracticable to have such a plant laid out on a purely departmental plan. The processes required and the departments in which the manufacture of an electric fan takes place have no connection with the different processes required in the construction of an electric transformer. The solution, therefore, lies in arranging the plant in divisions in which the production of widely different commodities is separated. Within each division there may be departments or cost centers where like classes of work are performed. **Divisionalization** permits gathering more accurate costs. In reality, each division is a small factory in itself.

In such cases costs may be centralized by using a separate **factory ledger** for each division, each such ledger being represented by a suitable account on the

general ledger of the main or central office. (For discussion and illustration, see section on Basic Cost Records.)

Where a variety of products is turned out in the same departments, **materials** and **direct labor costs** must be recorded through requisitions and time tickets. Factory overhead is best charged to the product through the use of predetermined burden rates.

PRODUCTION COSTS. Records of quantities are intended to measure the flow of product through the plant from the time of the receipt of new material to the time of final shipment. Daily **production reports** are compiled. These keep management informed of actual achievements with respect to scheduled production quotas and furnish one of the necessary elements in cost computations by the cost department.

Production figures may often be obtained from **meters** attached to machines, readings being taken at the beginning and end of each day or run. In some plants finished units are counted by timekeepers or inspectors, by either physical count or automatic scales. Daily reports of production for each process are summarized to constitute a monthly end-of-the-period production report.

Materials Costs. Accounting for materials under process costs is similar to that found in other cost systems. Where the number of raw material items is large, **stores ledger cards** are usually maintained for each kind or item of material with a materials controlling account in the general or factory ledger.

Raw materials may be requisitioned in the usual manner by formal **materials requisitions** and **bills of materials.** The requisitions must indicate the department in which the materials are used and the product for which they are requisitioned. This is necessary in order to analyze materials cost for the cost of production report.

In some process industries the use of materials requisitions may not be appropriate, in which cases **consumption reports** are used. Schlatter and Schlatter (Cost Accounting) discuss these situations:

> In many industries, the flow of material into the process is uniform and continuous —for example, the flow of wheat into the flour-milling processes or the flow of clinkers into the clinker-grinder in the cement plant. Because of the uniformity and continuity of the flow, the method of recording the usage of materials-in-process cost accounting usually differs from that described for job cost accounting

Consumption reports simplify process cost accounting. The reports may state the cost of materials put into production or may give the quantity of materials which is later priced for the accounting period: a day, week, or month. In either case the report must give the processes (or departments) in which the materials were put into production.

With the use of consumption reports it is generally unnecessary to distinguish between direct and indirect materials which are used in each process. In not distinguishing, however, there is a risk of losing control over materials cost.

According to Lang–McFarland–Schiff (Cost Accounting), the amount charged on the consumption report may be determined either by **formula** or by **proration.** They cite chemical plants as an example of the type of situation in which the quantity of each type of material consumed may be determined from the production record by the use of specific formulas. Where more than one product is being manufactured in a given department and the materials at first are charged to the department only, the materials cost must be prorated to the different products on an estimated basis by bulk (tonnage, gallons) or number of individual units.

An example of one form of consumption report is shown in Fig. 6, from Schlatter and Schlatter (Cost Accounting).

THE CONTINUOUS PROCESS COMPANY CONSUMPTION RECORD						
	Debits			Credits		
Date	Process I	Process IV	Process X	Material A	Material B	Processed Material

Fig. 6. Material consumption report.

Direct Labor Process Cost. The essential requirement is to analyze labor by processes. This involves classification and analysis of labor in all producing centers, and in addition, listing the indirect labor of service departments. Instead of job time tickets used in job order cost accounting, a **daily time ticket** for each employee furnishes an analysis by process or service department and gives the breakdown by direct and indirect labor.

The distinction in process cost accounting between direct and indirect labor is usually unnecessary, since both types may be charged to the same process account or department. While no distinction is needed in determining the cost of a process, it should be pointed out that combining direct and indirect labor costs makes the control of each more difficult if not impossible. This is particularly the case where labor standards are used.

Schlatter and Schlatter (Cost Accounting) summarize the labor information required in process cost accounting as follows:

1. Where was the labor performed? This information is necessary to determine the cost accounts affected.
2. What was the cost of the labor performed for each function which had a cost account? This information must necessarily include all labor costs, not just wages, so that the amount to be charged to each cost account can be definitely determined.
3. What are the amounts owed for the month: (a) to employees; (b) to the federal and state governments for taxes withheld from the earnings of the employees and for the assessments of taxes against the employer, based on the employees' wages; and (c) to the labor union for the dues withheld? This information is necessary in recording the correct credits to liability accounts at the end of the month, at which time the debits to the cost accounts for wages and other labor costs are made.

4. Who are the employees to be paid, and what is the net amount due each person on payday? This information must be obtained more frequently than the information for the end-of-the-month journal entry because paydays may come from two to five times a month; that is to say, the pay period is almost always less than a month.

Manufacturing Overhead Process Cost. As in the case of all cost systems, manufacturing overhead presents the greatest difficulties in accounting control. The accounting for manufacturing overhead is more complex when more than one product is manufactured in the plant or in the same departments. Even where only one product is produced, **seasonal or cyclical variations** may require different handling of this cost.

Management should know the amount of manufacturing overhead by type of cost for each department, and in total, and how it is distributed or applied to the product. In those industries where there is very little variation in the flow of production, all manufacturing overhead, analyzed by processes, is charged directly to the product. This procedure frequently applies to smaller process industries. If more than one manufacturing process is involved, there must be an appropriate distribution of the overhead to each process or department. In smaller **continuous-process plants,** such as bakeries and breweries, all manufacturing overhead is absorbed by the product when the plant is operating; when there is no production, manufacturing overhead which continues is a loss. Furthermore, under this arrangement, often no distinction is made between fixed and variable manufacturing overhead.

In many process industries a **predetermined overhead rate** is used to apply manufacturing overhead to the product. This method is particularly useful where production fluctuates during the year without a complete shutdown, as in many seasonal industries.

One variation which is sometimes introduced is to charge directly to the process materials, labor, and variable manufacturing overhead and to use a predetermined rate to prorate fixed overhead to the work-in-process account. Neuner (Cost Accounting) says: "Such proration would assume, as in standard costs, that idle capacity should be considered in measuring efficiency and that part of the underapplied manufacturing overhead should be charged against management as their responsibility. Proration would therefore be based upon normal production capacity."

Actual Overhead for Multi-product Plants. Where several products are produced simultaneously or in successive runs, overhead may be charged to products by:

1. Apportioning on some convenient basis the actual costs within each process to products worked on.
2. Using predetermined departmental overhead rates. The use of such rates has the effect of averaging costs over all products, and special care must be used in selecting the method of overhead apportionment.

More useful unit cost information is available when predetermined departmental overhead rates are used, and the trend is away from apportioning actual overhead to each product.

Predetermined Rates for Multi-product Plants. Predetermined rates for manufacturing overhead are used in most multi-product plants, and there are good reasons for doing so. Most multi-product plants manufacture at least some

products on a seasonal basis. To apportion actual costs would give widely fluctuating unit costs which would not have much meaning to management. Blocker and Weltmer (Cost Accounting) state that "Since most businessmen prefer to consider the year's overhead costs and production as a complete cycle of activities, they prefer to view the relationship of overhead costs to production as an average or normal charge per unit, thus neutralizing seasonal or monthly extremes." The effect on costs of **seasonal variations** of business can be the subject of separate studies.

Another good reason for using a predetermined rate is to provide management with an **index of efficiency** by comparing actual manufacturing overhead with absorbed overhead. This is particularly the case where the rate is based on standard costs.

Also, unit costs for each process may be computed at any time, daily, weekly, or monthly. Materials and labor costs are frequently available or easily accessible, and the use of a predetermined overhead rate provides management with total unit costs to manufacture. Being able to determine unit costs assists in the formulation of pricing policies and in the preparation of bids by the sales department.

The **computation of rates** is accomplished in three steps:

1. Classification and accumulation of overhead items on an estimated basis.
2. Distribution of overhead departmentally; for this purpose cost distribution sheets are used. The service departments are closed out and producing department totals are obtained.
3. Reduction of departmental overhead totals to a rate to be applied to production. For this purpose any suitable base may be used, such as unit of productive output, direct labor cost, direct labor hours, machine hours, or product hours.

PROCESS COST SHEET. Process cost sheets are often more complex and more formal than job order cost sheets because the former must show costs and quantities by departments. Often the process distribution sheet is used as a cost sheet. Lang–McFarland–Schiff (Cost Accounting) illustrate a typical process cost sheet in Fig. 7.

PRODUCTION BY SUCCESSIVE RUNS. In some plants production is **intermittent** rather than continuous. In such cases the product is processed in successive runs. This is, in effect, a **combination of job order and process costing.** It is job order costing in the sense that each run is represented by a production order and costs are accumulated thereon. It is process costing in the sense that costs are gathered for each process. The method is found either on a formal or informal basis in canneries, bottling works, bakeries, etc. The reasons for successive runs are:

1. Fulfillment of the need to provide a wide variety of products.
2. Lack of sufficient demand to make additional plant facilities economically feasible. Where the same machinery can be used to turn out a variety of products, such products are produced in rotation, unless demand is such that additional facilities make possible continuous runs on each product.
3. Seasonal and climatic conditions.

Accounting for Successive Runs. Blocker and Weltmer (Cost Accounting), in discussing vegetable canning costs, say:

The general ledger journal entries are the same in this type of processing as in the procedure explained for a factory or process producing a single product in a con-

NATIONAL SHALE BRICK COMPANY **PROCESS COST SHEET** FOR THE YEAR ENDED OCTOBER 30, 19—

	Power	General Factory Overhead	Quarry	Pans & Machines	Dryers	Setting	Kiln Firing	Unloading
Inventories, November 1					$ 280.00		$ 2,950.00 1,020.00 568.00	$ 893.75
Labor, Direct and Indirect	$ 7,000.00		$12,000.00	$36,000.00	8,000.00	$27,000.00	65,000.00	30,000.00
Materials and Supplies	5,000.00		3,000.00	15,000.00	1,500.00	750.00	3,000.00	4,000.00
Coal	6,000.00		2,000.00		5,000.00		55,000.00	
Royalties			6,300.00					
Insurance		$ 2,500.00						
Taxes		3,000.00						
Depreciation	1,750.00	400.00	1,000.00	5,500.00	750.00		26,250.00	
Superintendence		10,000.00						
Coke Sales							(7,000.00)	
Spoiled Brick Sales							(2,000.00)	
Service Department Distributions:								
Power	$19,750.00			17,775.00			1,975.00	
General Factory Overhead		$15,900.00						15,900.00
Process Costs and Transfers:								
1. Quarry (18,000,000 bricks at $1.35) (Exhibit A)			$24,300.00	24,300.00				
2. Pans and Machines (17,600,000 bricks at $5.6009) (Exhibit A)				$98,575.00	98,575.00			
3. Dryer (17,650,000 bricks)					$114,105.00			
to Setting Dept. (16,850,000 bricks at $6.4849) (Exhibit A)					$109,270.12	109,270.12		
Inventory (800,000 bricks at $6.0436) (Schedule 1)					4,834.88			
					$114,105.00			
4. Setting (16,000,000 bricks at $8.5638) (Schedule 2)						$137,020.12	137,020.12	
5. Kiln Firing (15,550,000 bricks)							$283,783.12	
to Unloading Dept. (15,100,000 bricks at $18.4033) (Exhibit A)							$277,889.12	277,889.12
Inventory at October 31, 19— Burned (100,000 bricks at $17.6317) (Schedule 2)							1,763.17	
Burning (250,000 bricks at $13.0978) (Schedule 2)							3,274.45	
Green (100,000 bricks at $8.5638) (Schedule 2)							856.38	
							$283,783.12	
6. Unloading (15,155,000 bricks at $21.6881) (Exhibit A)								$328,682.87
Cost of Sales (14,500,000 bricks at $21.6881)								$314,477.16
Inventory (655,000 bricks at $21.6881)								14,205.71
								$328,682.87

Fig. 7. Typical process cost sheet.

Full-pack Canning Factory
Analysis of Cost of Production for Successive Runs
June 1 to July 1, 19—

Production costs	Asparagus		Peas		Beans		Spinach		Total Cost
	Cost	Cost per unit	Cost	Cost per unit	Cost	Cost per unit	Cost	Cost per unit	
Materials:									
Vegetables..................	$ 750.00	$0.05	$1,200.00	$0.03	$ 400.00	$0.02	$1,500.00	$0.03	$ 3,850.00
Cans and lids................	325.50	0.0217	868.00	0.0217	434.00	0.0217	1,085.00	0.0217	2,712.50
Labels.....................	13.50	0.0009	28.00	0.0007	14.00	0.0007	40.00	0.0008	95.50
Boxes......................	45.00	0.003	100.00	0.0025	50.00	0.0025	125.00	0.0025	320.00
Miscellaneous supplies......	60.00	0.004	120.00	0.003	40.00	0.002	100.00	0.002	320.00
Total material costs.......	$1,194.00	$0.0796	$2,316.00	$0.0579	$ 938.00	$0.0469	$2,850.00	$0.057	$ 7,298.00
Labor:									
Direct labor payroll........	$ 450.00	$0.03	$ 800.00	$0.02	$ 300.00	$0.015	$1,500.00	$0.03	$ 3,050.00
Supervision payrolls........	150.00	0.01	200.00	0.005	100.00	0.005	500.00	0.01	950.00
Total payroll costs.......	$ 600.00	$0.04	$1,000.00	$0.025	$ 400.00	$0.02	$2,000.00	$0.04	$ 4,000.00
Factory overhead costs.......	300.00	0.02	600.00	0.015	400.00	0.02	500.00	0.01	1,800.00
Total costs................	$2,094.00	$0.1396	$3,916.00	$0.0979	$1,738.00	$0.0869	$5,350.00	$0.107	$13,098.00
Total production, No. 2 cans..	15,000		40,000		20,000		50,000		125,000

Fig. 8. Monthly analysis of cost report.

tinuous manner. Material, labor, and factory overhead are charged to each process at the end of each accounting period. The difference lies in the use of subsidiary records. A separate analysis sheet is prepared for each run to show the material, labor, and overhead costs which can be definitely identified with the vegetable being processed. Likewise, the number of hours that the equipment is used for each vegetable and the total production of cans are carefully recorded. At the end of each accounting period, labor costs and factory overhead costs which cannot be identified with a separate run are allotted to the production of each vegetable, usually on a single distribution base; the choice is among the total number of production hours for each vegetable, the total number of cans of each vegetable produced, and the number of pounds of each vegetable packed.

Fig. 8 shows a **monthly cost report** for a vegetable cannery suggested by Blocker and Weltmer. In this case No. 2 cans were the only size used, and unit costs therefore were computed on the basis of the number of cans produced. If vegetables had been packed in several sizes of cans, the unit cost determination could have been made on the basis of the number of pounds packed.

Unit Costs and Effective Production

UNIT COSTS. The distinguishing characteristic of process costs is the requirement to compute unit costs which are necessary to (1) give essential comparative cost data to management, (2) provide a basis for transferring costs from one process to the next, and (3) provide a basis for inventory pricing.

Unit costs are easily determinable in a simple manufacturing process where the only product is manufactured in one step and where there is no uncompleted product. The elementary formula is

$$\text{Unit cost} = \frac{\text{material} + \text{labor} + \text{manufacturing overhead}}{\text{quantity produced}}$$

Quantity produced may be expressed in units, weight, or similar measures of production.

EFFECTIVE PRODUCTION. Determining unit cost is somewhat more complicated when there are unfinished units on hand at the beginning or end of an accounting period. There are some circumstances in which it may be permissible to ignore these inventories in computing the unit costs. Schlatter and Schlatter (Cost Accounting) say:

> If the quantity and value of work within a process at the end of a period are small as compared with the total quantity and value passed through the process in the period, or if the quantity and value of work within a process are approximately constant and relatively small at all times, the inventory may be ignored without materially affecting the reliability of the unit cost figures.

In a discussion of process-type industries at an annual convention of the National Association of Accountants, as reported by Old (NAA Bulletin, vol. 35), a question was raised as to how widely the strict methods for costing work in process were followed in practice. The description of methods in actual use in companies gave the impression that a number of companies used short cuts. In some cases the reasons given for the short cuts were those cited by Schlatter and Schlatter.

Where the conditions specified above do not hold, it is advisable, in order to obtain correct unit costs, to spread the total costs over all work done in a department, including both completed and unfinished units. To accomplish this, the

work of the department must be expressed in terms of a common denominator which represents the total work of a department or process in terms of fully completed units. This common denominator is called by a number of different names: **effective production, equivalent production, effective effort,** or **equivalent effort.** It represents the number of complete units that would have been produced if all the work performed during the period had been applied to units which were begun and finished during the period. The number of complete units represented by the effective or equivalent production is divided into the total costs to obtain the unit cost. This idea rests on the assumption that the work done in producing 100 units of one-half completed product is equivalent to the work done in fully completing 50 units.

Stage of Completion. To obtain a figure for effective production, complete information must be available as to the stage of completion of both opening and closing inventories. In extreme cases the stage-of-completion figures must be given separately for materials, labor, and overhead. If all materials are issued at the beginning of a process, the full materials cost must be charged to inventory; as for labor and overhead, inventory may be only partially completed, depending on the length of processing time; hence only a portion of labor and overhead costs must be charged to the inventory. If materials, labor, and overhead are consumed uniformly throughout the process, a single computation of effective production suffices.

Methods of Computing Effective Production. There are several procedures for computing effective production. In the first method all figures except the final one are expressed in terms of **incomplete units**; i.e., units on which no work at all has been done. To illustrate, assume a beginning inventory of 12,000 units, one-third completed; 100,000 units put into process; 104,000 units brought to completion; and an ending inventory of 8,000 units, one-fourth completed.

Method I

1. Inventory at beginning, equivalent incomplete units (12,000 × ⅔)	8,000 units
2. Add quantity put into production	100,000
3. Total incomplete units handled	108,000 units
4. Less inventory at end, equivalent incomplete units (8,000 × ¾)	6,000
5. Effective production, equivalent completed units	102,000 units

The second method analyzes the work of a period for each stage of a department's work in terms of **fully completed units.**

Method II

	Equivalent Completed Units
1. Inventory at beginning, work needed to complete during current period, found by applying percentage to units in initial inventory (12,000 × ⅔)	8,000
2. Units started and finished during current period; i.e., number of new units started, minus units in final inventory (100,000 − 8,000)..	92,000
3. Units started but not finished; i.e., percentage done on final inventory (8,000 × ¼)	2,000
4. Effective production	102,000

The third method also deals in fully completed units and varies only slightly from the second method.

Method III

1. Units completed during the period	104,000 units
2. Ending work in process inventory, i.e., units started but not finished (8,000 × ¼)	2,000
	106,000
3. Beginning work in process inventory, i.e., work done in previous period which is in units brought to completion in this period (12,000 × ⅓)	4,000
4. Effective production	102,000 units

Newlove (Process Costs) observes that Method III is the easiest formula to remember.

OPERATION COSTS. Operation costing represents a refinement of process cost procedure. It implies cost determination by operations instead of by processes. In the production of like articles or finished materials where units cannot be distinguished easily one from another, a cost accounting system to record costs of product by operations may be desirable.

Gillespie (Cost Accounting and Control) describes operation costing as a type of process costing:

> The focal point is an operation or a group of closely related operations. Setting up an operation cost system involves identifying specific measurable operations being performed repetitively for significant periods and selecting work units or cost units for measuring the production which comes out of each operation. A unit conversion cost is computed for each operation by dividing cost by work units or cost units produced.

Blocker and Weltmer (Cost Accounting) assume that all units processed in the same operation are uniform and have the same cost. They describe the cost per unit as an average cost obtained at the end of each accounting period by dividing the costs of an operation by the number of units completed in the operation center. They indicate that, usually, materials costs are separated from operation costs, composed of labor and factory overhead assigned to operation centers. The total cost of a product is ascertained by adding the costs of the several operations through which it passes to the materials cost.

Blocker and Weltmer observe that it may be advantageous to have an account for each operation in the general ledger if there are not too many operations. On the other hand, they indicate:

> It may be more practical to carry a general ledger account for each large process or department, such as the foundry or machine shop, and to have, as a subsidiary record in support of it for each operation center within the process, an analysis sheet which can be used as a costing medium. The general ledger account for the process or department would show total costs, while the analysis sheet for each operation would show detailed costs assigned to the operation and would be used as a basis for computing unit costs.

One drawback of operations costing is that, because the plant is divided up into so many small units, there tends to be more expense and greater difficulty in distributing the manufacturing overhead. On the other hand the use of operation costs enables some companies to avoid the more costly job order method.

Operation costs may be regarded as process costs in miniature. In general, both types of cost have the same problems and procedures. Operation costing, however, by focusing on a smaller area of activity, gives management a greater opportunity to control costs.

SINGLE-STAGE PROCESS COSTING. In single-stage process costing, only one product is manufactured, and this product requires only one step in the manufacturing process. Unit cost information is required to determine the ending inventory and the value of product transferred to inventory or cost of sales.

This information is frequently summarized in a **cost of production report,** which should include the following information:

1. Costs incurred for current month, including materials, labor, and manufacturing overhead.
2. Cost of items completed and on hand at beginning and end of accounting period.
3. Cost of work in process at beginning and end of accounting period.
4. Cost of items transferred to finished goods.

The form of the report will vary. One suggestion for the form such a cost-of-production report may take is given here.

Cost of Production Report

Costs to be accounted for	
Costs for current month	
Materials	$xxxx
Labor	xxxx
Manufacturing overhead	xxxx
Total costs for month	$xxxx
Completed and on hand at beginning of month	xxxx
Work in process at beginning of month	xxxx
Total costs to be accounted for	$xxxx
Accounted for as follows:	
Transferred to finished goods	$xxxx
Completed and on hand at end of month	xxxx
Work in process at end of month	xxxx
Total costs accounted for	$xxxx

In addition to the cost of production report, there should be a **production report** which accounts for all units put into production.

Determination of Inventory Cost. In single-stage process accounting there are four situations involving inventories:

Case I. No opening and no closing inventory of work in process.
Case II. No opening inventory but a closing inventory of work in process.
Case III. Both opening and closing inventories.
Case IV. An opening inventory but no closing inventory of work in process.

In all four cases it is assumed that materials are added uniformly during the process. In other words, units in work-in-process inventory which are 40 percent complete would have at that time 40 percent of all the materials that would be in the units when they were completed. This means that the equivalent production should be divided into the total cost to obtain a unit cost including materials,

labor, and overhead. In the many instances where materials are not added uniformly during the process, a separate computation has to be made for them. If, for example, all the materials for each unit were put into process at the beginning of the processing, then the ending work in process inventory will have 100 percent of the unit materials cost, regardless of its stage of completion. In this case the equivalent production figure would be divided into the total of labor and manufacturing overhead cost to obtain a unit **conversion cost**. This would be applied to the ending inventory in the same way that the total unit cost is used in Case III. The materials cost would, of course, be added to the conversion cost to obtain the total cost of the ending inventory.

Case III is the most involved and is the only one illustrated here. The **first-in, first-out method** (discussed in this section under Treatment of Work in Process) is used, assuming cost and production data given in subsequent computations.

Calculation with Both Opening and Closing Inventories. Effective production must be computed where there are opening and closing inventories. The following case illustrates the procedure:

Process A

Opening inventory	$ 200
Materials	6,000
Labor	3,000
Overhead	3,000

Production data:

	Units
Opening inventory, 30 percent complete	500
Put into Process A	10,000
Completed and transferred	9,500
Closing inventory, 40 percent complete	1,000

A. Effective Production, by Method 1:

	Units
Opening inventory, 70 percent incomplete	350
Put into process	10,000
Total incomplete units handled	10,350
Less inventory at end, 60 percent incomplete	600
Effective production	9,750

Method II may be employed to check the above result as follows:

	Completed Units
1. Portion of opening inventory completed in current period (500 × 70%)	350
2. Started and finished during current period (10,000 − 1,000)	9,000
3. Portion of closing inventory completed in current period (1,000 × 40%)	400
Effective production	9,750

B. Unit Current Process Cost:

$$\frac{\text{Total current costs}}{\text{Effective production}} = \frac{\$12{,}000}{9{,}750} = \$1.230769$$

C. Closing the Process Account:

1. Total debits	*$12,200.00*
2. Less value of closing inventory (1,000 × 40% × $1.230769)	*492.31*
3. Balance, representing transfer to B	*$11,707.69*

D. Proof of Charges Transferred to B: There were 9,500 units transferred to the next process. These represented costs incurred as follows:

1. Opening inventory	
500 units; cost incurred in prior period	$ 200.00
500 units; cost incurred in current period (500 × 70% × $1.230769)	430.77
2. Started and finished in current period (9,000 × $1.230769)	11,076.92
Total transfer to B	$11,707.69

MULTIPLE-STAGE PROCESS COSTING. In many, if not most, process industries, more than one step is required in the manufacturing process, and the materials pass through several departments in succession in the conversion to finished goods. Management needs to know the quantity produced, total cost, and unit cost by department. Thus the cost-of-production report must show the costs transferred from one department to the next, as well as the total cost for each department.

Accounting for Addition of Materials. It is not unusual in process industries for most, if not all, of the materials used in the product to be placed into production in the first department. Where materials are added in subsequent departments the effect on production will be either that of (1) no increase in quantity or units of items produced, or (2) an increase in the quantity of the product produced. For example, where the additional materials cost is for accessories, paint, or packaging, there would be no increase in the quantity produced. Unit cost would be increased, but no adjustment would be required in the unit costs of the items transferred into the department.

In other industries, adding materials in departments subsequent to the first department will increase the quantity produced. This is common in the chemical industry and others where the product is a bulk liquid. After adding the materials, the unit cost of the product transferred into the department must be adjusted to spread the cost over the greater quantity of production.

Treatment of Work in Process. In the computation of unit cost for materials, labor, and overhead, attention must be given to the beginning and ending work in process. All materials may have been added, but additional labor and overhead is required to complete the units in process. In the case of multiple-stage process costing for departments subsequent to the first department, work in process is fully completed with regard to the preceding departments and only partially completed for the current processing department. The stage of completion of the work in process is reflected in the equivalent production computation.

In the accounting treatment of work-in-process inventories, either the first-in, first-out or the average cost method may be used. Vance (Theory and Technique of Cost Accounting) comments:

It is usually assumed that goods move through the processes on a first-in, first-out basis. On this basis, beginning inventory of work in process is the first work to be completed. Since production of finished work in a process is almost always larger

than the opening inventory of work in process, none of the beginning inventory ordinarily is in the closing inventory of work in process. Goods turned out of a process during a period must be divided into two parts for purposes of the computation of equivalent units where there is beginning inventory of work in process, and first-in, first-out unit cost calculations are made. These parts are (1) the units representing beginning inventory that is partly processed in the current period, and (2) the units that are both started and finished within the current period.

The **first-in, first-out method** is applied in this section under Single-Stage Process Costing.

The **average cost method** requires the following steps, according to Neuner (Cost Accounting):

1. The inventory of the initial work in process must be stated in analyzed form; that is, separate figures must be given for materials cost, labor cost, and manufacturing overhead cost.
2. The number of units in the initial inventory are added to the units received into the department during the period, giving the total units to be considered.
3. The cost in the initial inventory of the work in process for each element of cost is added to the corresponding cost for the same element for work performed during the period, thus obtaining the total cost for each element.
4. Dividing the total costs obtained in step (3) by the corresponding equivalent production for each element gives the average unit departmental cost for that element.

The average cost method is used in this section under Steps in Closing Process Accounts. The detailed computation for the average cost method is shown only for Department I.

Matz–Curry–Frank (Cost Accounting) compare the use of average and first-in, first-out costing as follows:

A comparison of these two methods of costing used in a process cost system indicates that each method possesses certain advantages. It would be rather arbitrary to make any statement to the effect that one method is either more accurate or simpler than the other. The selection of one or the other method depends entirely upon the nature of a company's manufacturing process or the type of information desired from the cost system.

Accounting for Lost Units

QUANTITY CONTROL. In general the treatment of waste, scrap, and shrinkage is closely connected with the subject of quantity control, and anything affecting quantity produces an effect on unit costs. In discussing quantity control, Gillespie (Cost Accounting and Control) states:

The need for quantity control in a process cost system is clear. In the first place, quantity control safeguards the accuracy of the quantity figures used in computing unit costs. Obviously the unit costs are not correct if the quantities upon which they are based are wrong. In the second place, quantity control is an over-all check on cash payments for materials. If the materials quantities per the control record tie to physical inventory, it is reasonably certain that the quantities of materials paid for on incoming invoices were the correct quantities. And finally, quantity control is an over-all check on billing to customers.

The **cost department** is charged with the duty of computing total and unit costs of production. In doing so, quantities entering a process must be reconciled

with quantities leaving the process, and the loss, if any, must be analyzed into those factors that are controllable and those that are noncontrollable. Complete quantity control reconciles raw materials purchases with the flow of such materials through the manufacturing processes to finished goods and finally to sales.

Quantity Control as Index of Efficiency. One way of controlling quantities is to establish process yields. Lang–McFarland–Schiff (Cost Accounting) report that:

> . . . a fairly common practice in process cost plants is to compute material yields along with production cost data and reports. Such yields are ordinarily obtained in percentage form computed from the following formula:

$$\text{Percent yield} = \frac{\text{product yield}}{\text{product input}} \times 100 \text{ percent}$$

Measurement for both quantities may be weight units or units of product. Yield formulas may be used as **indexes of operating efficiency.**

ACCOUNTING FOR LOSSES. Units of production may be lost in a process industry through **shrinkage, evaporation,** or **spoiled or defective work.**

Many shrinkages are due to the nature of the operations and cannot be controlled. Therefore the most common method in accounting for shrinkage is **treatment by neglect.** This means spreading the total costs of the process over the good units obtained from the process, thus increasing the unit cost of these units because they absorb the cost of shrinkage.

The same method is often applied in the treatment of **spoilage,** at least for what can be considered the normal amount of spoilage. Under this method no journal entries are required, but each process must keep a record of shrinkage and spoilage.

Lang–McFarland–Schiff (Cost Accounting) point out that shrinkage and spoilage losses may occur at the beginning of a process, during a process, or at the end of a process (as a result of final inspection). They say:

> For the sake of simplicity the first two may be treated as though the lost units had never been started in the process In this way the costs are spread over the equivalent units produced, that is, over the units completed as well as those still in process. Where spoilage occurs at the end of a process, the loss is charged only against the good units produced. No part of the loss is therefore chargeable against the closing inventory of work in process. Both methods are illustrated in the following example:

Process A

Inventory	$ 2,000 00	To Process B	$?
Material	5,000.00	Inventory	?
Labor	10,000.00		
Manufacturing Overhead	8,000.00		

Production data:

Opening inventory 25 percent complete	4,000 lb.
Put into process	12,000 lb.
Transferred to B	10,000 lb.
Closing inventory 20 percent complete	5,000 lb.

Material is placed in process at the beginning of the process.

Required. Find the value of the closing inventory and of the transfer to B on two assumptions:

1. Spoilage of 1,000 lb. occurred during the process.
2. Spoilage occurred at end of process. There is no salvage value.

Solution:

Assumption 1. Spoilage During Process

	Material	Labor	Overhead	
1. Effective production.				
(a) Incompleted Units Method				
Inventory (beginning)	0	3,000	3,000	
Put in process (12,000 less 1,000 lb.)	11,000	11,000	11,000	
Total incompleted units handled.	11,000	14,000	14,000	
Less: Inventory (ending)	0	4,000	4,000	
Effective production	11,000	10,000	10,000	
(b) Completed Units Method				
Work completed in opening inventory	0	3,000	3,000	
Started and finished this period ..	6,000	6,000	6,000	
Work completed on closing inventory	5,000	1,000	1,000	
Effective production	11,000	10,000	10,000	
2. Current process costs	$5,000.00	$10,000.00	$8,000.00	
3. Unit process costs	$ .454545	$1.00	$.80	$ 2.254545
4. Work in process (ending):				
Material (5,000 × $ .454545)......	$2,272.73			
Labor (5,000 × $1.00 × 20%)...		$ 1,000.00		
Overhead (5,000 × $ .80 × 20%)...			$ 800.00	
Total				$4,072.73
5. Finished goods transfer ($25,000.00 − $4,072.73)				$20,927.27
6. Unit cost of finished goods				$2.092727

PROOF OF COST OF TRANSFERS

There were transferred to the next process 10,000 units, of which 6,000 were started and finished this period, and 4,000 were from the opening inventory.

Inventory in process (beginning)	$2,000.00	
Work required to complete inventory:		
Labor (4,000 × $1.00 × 75%)........................	3,000.00	
Overhead (4,000 × $ .80 × 75%)........................	2,400.00	$ 7,400.00
Started and finished this period:		
Material (6,000 × $ .454545)..........................	$2,727.27	
Labor (6,000 × $1.00)..............................	6,000.00	
Overhead (6,000 × $ .80)..............................	4,800.00	13,527.27
Total value of transfers		$20,927.27

Assumption 2. Spoilage at End of Process

	Material	Labor	Overhead	
1. Effective Production.				
(a) Incompleted Units Method				
Inventory (beginning)	0	3,000	3,000	
Put in process	12,000	12,000	12,000	
Total incompleted units handled.	12,000	15,000	15,000	
Less inventory (ending)	0	4,000	4,000	
Effective production	12,000	11,000	11,000	
(b) Completed Units Method				
Work completed on opening inventory	0	3,000	3,000	
Started and finished this period (6,000 + 1,000 spoiled)	7,000	7,000	7,000	
Work completed on closing inventory	5,000	1,000	1,000	
Effective production	12,000	11,000	11,000	
2. Current process costs	$5,000.00	$10,000.00	$8,000.00	
3. Unit process costs	$ .416667	$.909091	$ .727273	$2.053031
4. Work in process (ending):				
Material (5,000 × $.416667) ...	$2,083.33			
Labor (5,000 × $.909091 × 20%)		$ 909.09		
Overhead (5,000 × $.727273 × 20%)			$727.27	
Total				$3,719.69
5. Finished goods ($25,000 − $3,719.69) .				$21,280.31
6. Unit cost of finished goods				$ 2.128031

PROOF OF COST OF TRANSFERS

There were transferred to the next process 10,000 units, of which 6,000 were started and finished this period, and 4,000 were from the opening inventory.

Inventory in process (beginning)	$2,000.00	
Work required to complete inventory:		
Labor (4,000 × $.909091 × 75%)......................	2,727.27	
Overhead (4,000 × $.727273 × 75%)......................	2,181.82	$ 6,909.09
Started and finished (good units):		
Material (6,000 × $.416667)............................	$2,500.00	
Labor (6,000 × $.909091)............................	5,454.55	
Overhead (6,000 × $.727273)............................	4,363.64	12,318.19
Value of units spoiled at end of process whose cost is absorbed by good units:		
Material (1,000 × $.416667)............................	$ 416.67	
Labor (1,000 × $.909091)............................	909.09	
Expense (1,000 × $.727273)............................	727.27	2,053.03
Total value of transfer		$21,280.31

To impress on management the effect of abnormal shrinkage and spoilage, separate costs for such losses may be computed. Neuner (Cost Accounting) says:

This method attempts to treat as an additional manufacturing overhead cost, listed separately in the department in which the lost units occur, the lost unit cost resulting

from the work done on the lost units in the preceding departments. As such, it would have to be apportioned on the basis of equivalent production for the department in which the loss occurs.

Effect on Costs from Preceding Departments. Regardless of the manner of handling cost of lost units in the department where they were lost, an adjustment must be made in the unit costs for work performed in preceding departments. This adjustment to correct the unit cost is made by dividing the total cost transferred into the department by the equivalent production of good units of the department. The difference between the corrected unit cost and the cumulative unit cost from the preceding department is the lost unit cost.

Neuner (Cost Accounting) points out that this adjustment in unit cost is affected by (1) the addition of materials which increase the number of units in production, and (2) work-in-process inventory at the beginning of the period. A rule is stated for each situation:

1. If the number of units are increased in a department after the first because of added materials, the unit cost for the preceding departments must first be adjusted for the added materials before computing the lost unit cost.
2. When there is a work-in-process inventory at the beginning of the period, it is not possible to determine whether the lost units came from this inventory or from the units received into the department during the period. Therefore all the units must be considered when calculating the lost unit cost. This means computing an average unit cost for the work done in the preceding departments before computing the lost unit cost.

RECLAIMED MATERIALS. Reclaimed or salvaged materials are usable stores items which have been salvaged from spoiled work. Where it is desired to record spoilage costs separately in the accounts, this may be accomplished through the use of spoilage reports, showing spoilage cost, reclaimed material, etc., which form the basis for a monthly journal entry:

Manufacturing Overhead Control	$xxx	
Stores	xxx	
Process A		$xxxx

The debit to Manufacturing Overhead is supported by detailed postings to the departmental **standing orders.** The debit to Stores account is supported by **stores ledger** for (1) reclaimed material item, and (2) scrap account.

Accounting Entries and Statements

COMPARISON WITH JOB ORDER COSTING. From a bookkeeping point of view, the chief difference between job and process costing lies in the handling of the Work-in-Process account or accounts. Subsequent to the work-in-process stage, the accounting for Finished Goods and Cost of Sales is the same in any system. In process costing, the general scheme is to transfer charges from process to process until the transfer to Finished Goods is effected.

STEPS IN CLOSING PROCESS ACCOUNTS. In closing process accounts, the following steps must be taken:

1. Compute effective production from given data.
2. Calculate net conversion or net process cost.
3. Compute unit conversion or unit process cost (item 2 divided by item 1).

ALTON MANUFACTURING COMPANY

SUMMARY COST OF PRODUCTION STATEMENT

For Month of February 19—

	Department I		Department II		Department III	
	Cost	Per Unit	Cost	Per Unit	Cost	Per Unit
Cost transferred from preceding departments:						
Work in Process, 2-1-—	0		$ 7,500.00	$0.50	$ 4,000.00	$1.00
Transferred into Department during February	0		31,800.00	0.53	4,800.00	0.96
Transferred into Department during February	0		0	0	63,310.00	0.974
Total Cost of Work Done in Preceding Departments	0		$39,300.00	$0.524*	$72,110.00	$0.97446
Additional Costs for Lost Units		0		0		$0.013351
						0.987811
Costs in Department:						
Work in Process, 2-1-—:						
Material Cost	$ 3,000.00		0		0	
Labor Cost	750.00		$ 1,500.00		$ 400.00	
Manufacturing Overhead Cost	250.00		800.00		280.00	
Costs for the Month of February:						
Material Costs	22,600.00	$0.32	0		0	
Labor Costs	9,000.00	0.15	18,100.00	$0.28	14,300.00	$0.21
Manufacturing Overhead Costs	3,650.00	0.06	11,100.00	0.17	10,220.00	0.15

Total Departmental Costs.....	$39,250.00	$0.53	$31,500.00	$0.45	$25,200.00	$0.36
Cost of Goods Completed in January but Not Transferred.....			$ 4,800.00	$0.96		
CUMULATIVE COST TOTAL.......	$39,250.00	$0.53	($70,800.00 (4,800.00	$0.974) 0.96)	$97,310.00	$1.347811
Transferred to Next Department...	$31,800.00		$68,110.00		0	
Work in Process, 2/28/--:						
Cost in Preceding Departments..	0		$ 5,240.00		$ 3,897.84	
Lost Unit Costs...............	0		0		53.40	
Material Cost................	$ 6,400.00		0		0	
Labor Cost..................	750.00		1,400.00		210.00	
Manufacturing Overhead Cost....	300.00		850.00		150.00	
Total Work in Process.......	$ 7,450.00		$ 7,490.00		$ 4,311.24	
Transferred to Finished Goods Stockroom....................	0		0		$92,998.96	
CUMULATIVE COST TOTAL.......	$39,250.00		$75,600.00		$97,310.20**	

*Average unit price ($39,300.00 ÷ 75,000 pounds).

**Discrepancy of $0.20 due to decimals in unit costs.

Fig. 9. Summary statement of cost of production.

QUANTITY PRODUCTION REPORT (In Pounds)

	Department I	Department II	Department III
QUANTITY TO BE ACCOUNTED FOR:			
Pounds in Process, 2-1——	10,000	20,000	4,000
Put into Process during February	76,000	60,000	70,000
To Be Accounted For	86,000	80,000	74 000
QUANTITY ACCOUNTED FOR AS FOLLOWS:			
Completed and Transferred to Next Department	60,000	70,000	0
Completed and on Hand, 2-1——	0	0	0
Work in Process, 2-1——	20,000*	10,000**	4,000***
Lost or Spoiled in Production	6,000	0	1,000
Completed and Transferred to Finished Goods Stockroom	0	0	69,000
Total Accounted For	86,000	80,000	74,000

*ALL MATERIAL, 1/4 LABOR, 1/4 MANUFACTURING OVERHEAD.
**ONE-HALF LABOR, 1/2 MANUFACTURING OVERHEAD.
***ONE-FOURTH LABOR, 1/4 MANUFACTURING OVERHEAD.

Fig. 10. Quantity production report.

4. Credit process account for value of closing Work-in-Process Inventory on the basis of
   a. Unit conversion or unit process cost, taking into account stage of completion.
   b. Full transferred unit cost.
5. Balance of process account represents charge to be transferred to the next process or to Finished Goods.

Neuner (Cost Accounting) illustrates the process cost procedure in a problem about the Alton Manufacturing Company. Fig. 9 provides the summary statement of cost of production and Fig. 10 the quantity production report.

Newlove (Process Costs) says the **quantity reports** are sometimes called **flow statements** or **schedules of units to be accounted for and of units accounted for.** He states that these quantity reports, "which show the transfers-in and transfers-out for the successive inventories arrayed in the order in which they occur in the manufacturing processes, are vitally important."

The **average cost method** of computation of unit cost for material is shown here for Department I only. The figures for costs and quantities used in this computation may be obtained from the two reports shown in Figs. 9 and 10.

	Quantity	Cost Value
In process, February 1	10,000 lb.	$ 3,000
Put into process during February	76,000	22,600
Total	86,000 lb.	$25,600
Units lost	6,000	
Equivalent production	80,000 lb.	$25,600

Then, $\frac{\$25{,}600}{80{,}000} = \$.32$ per lb. average cost for materials

A similar procedure is followed by Neuner (Cost Accounting) to compute the **unit costs** in Department I for labor and overhead for the month of February as shown in the following tabulation.

	Actual Production (including W-I-P at Beginning of Month)	Equivalent Production (including W-I-P at Beginning of Month)	Total Cost (including W-I-P at Beginning of Month)	Unit Cost
Completed	60,000	60,000		
In Process, Feb. 28, ¼ complete	20,000	5,000		
Lost in production	6,000			
Total	86,000	65,000		
Labor costs ($750 + $9,000)			$9,750	
Labor unit cost ($9,750 ÷ 65,000)				$0.15
Overhead costs ($250 + $3,650)			$3,900	
Overhead unit cost ($3,900 ÷ 65,000)				$0.06

The **journal entries** required to record the **information** shown in the illustration are:

(1)

Work in Process, Dept. I	$35,250.00	
Stores		$22,600.00
Payroll		9,000.00
Manufacturing Overhead		3,650.00
To record costs in Department I for February.		

(2)

Work in Process, Dept. II	61,000.00	
Work in Process, Dept. I		31,800.00
Payroll		18,100.00
Manufacturing Overhead		11,100.00
To record costs in Dept. II during February.		

(3)

Work in Process, Dept. III	92,630.00	
Work in Process, Dept. II		68,110.00
Payroll		14,300.00
Manufacturing Overhead		10,220.00
To record costs in Dept. III for February.		

(4)

Finished Goods	$92,998.96	
Work in Process, Dept. III		$92,998.96
To record cost of work completed during February.		

After these journal entries have been posted, the **ledger accounts** appear as follows:

Work in Process, Dept. I

2/1	Balance	4,000.00	2/28	(2)	31,800.00
2/28	(1)	35,250.00			

Work in Process, Dept. II

2/1	Balance: Completed	4,800.00	2/28	(3)	68,110.00
2/1	Uncompleted	9,800.00			
2/28	(2)	61,000.00			

Work in Process, Dept. III

2/1	Balance	4,680.00		(4)	92,998.96
2/28	(3)	92,630.00			

Finished Goods

2/28	(4)	92,998 96			

PROCESS COST STATEMENTS. In general the monthly operating statements depend on the nature of the industry, size of plant, and the degree to which management is aware of a need for cost reports and statistics in controlling operations. In process cost plants, **departmental production cost analysis** is usually the first and most basic report prepared. It is a direct outgrowth of the departmental unit cost computations, valuation of transfers, inventories in process, spoilage, etc. The statements themselves may be very simple or become very complex depending on:

1. Number of products manufactured.
2. Extent of subclassifications desired:
   a. By products.
   b. By elements of cost.
   c. By departments or processes.
   d. Or by any combination of the preceding items.

Monthly Reports. Rogers and Boddie (NAA Bulletin, vol. 36) illustrate an **end-of-month report** and **cost-of-production report** for the machining department of a shell manufacturer in Figs. 11 and 12:

END OF MONTH REPORT—MACHINING DEPARTMENT

Month Ended ______________, 19___.

Units in process, first of month	11,214	
Put into process during the month	70,573	
Completed and transferred (number of units palletized during month)	64,682	
Work in process, end of month	13,773	
Lost or spoiled in production (materials issued to machine line but not used)	3,332	
Direct materials:		
Rotating band blanks	2,495	pieces
Base plates	2,613	pieces
Olive drab paint	68	gal.
Acid proof black paint	40	gal.
Packing and crating material:		
Barrier paper	159	sheets
Paper sleeves	3,093	pieces
Steel banding tape	1	roll
Galvanized wire	3	rolls
Connectors	2,364	pieces
Scrap data: (weight of turnings, scrap shells, and any other steel scrap accumulated in the machine lines)		
A. Steel scrap No. 12	122.93	gross tons
B. Steel scrap No. 6	-0-	gross tons
C. Steel scrap No. 23	379.50	gross tons
Weight of spoiled bands and brass turnings recovered	16,790	lb.
Quantity of spoiled bands accumulated	1,831	

Fig. 11. Departmental end-of-month report.

COST-OF-PRODUCTION REPORT FOR MACHINING DEPARTMENT
Month Ended ____________, 19__

	Materials	Labor	Burden	Total	Equivalent Production
Work in process first of month (11,214)	$ 37 953 10	$ 2,592 66	$ 5 993 79	$ 46 539 55	
Less bands and base plates	(457 51)			(457 51)	
Net value of forgings in process first of month	37 495 59				
Added during month (70 573 units)	265 640 79			265 640 79	
Less cost of spoiled units (3 332)	(11 791 61)	(1,365 79)	(2,487 84)	(15 645 24)	
Scrap value of turnings	(13 702 66)			(13 702 66)	
Net value of forgings	277 642 11				78,455
Rotating bands	23 416 50			23 416 50	65,395
Base plates	849 14			849 14	65 318
Paint	1,770 61			1,770 61	64,682
Palletizing			6,919,83	6 919 83	64,682
Direct labor		54 072 97		54,072 97	67,457
Burden			181 680 90	181 680 90	67,457
Total manufacturing cost	$303 678 36	$55 299 84	$192 106 68	$551 084 88	
Unit costs					
Forging	$ 3 5389			3 5389	78 455
Band	3581			3581	65,395
Base plate	0130			0130	65 318
Paint	0274			0274	64,682
Palletizing			$ 1070	1070	64 682
Labor		$ 8198		8198	67 457
Burden			2 7418	2 7418	67,457
Total	$ 3 9374	$ 8198	$ 2 8488	$ 7 6060	
Transferred to inventory (64 682 units)	$254 678 91	$53,026 30	$184 266 08	$491 971 29	
Work in process (13 773 units)	48 999 45	2,273 54	7,840 60	59,113 59	
Total departmental cost	$303 678 36	$55,299 84	$192 106 68	$551 084 88	
Unit value of work in process	$ 3 5576	$ 1651	$ 5693	$ 4 2920	

Fig 12 Departmental cost-of-production report

Detailed Cost Statements. The detailed cost statements for a frozen meals manufacturer are illustrated by McCullagh (NAA Bulletin, vol. 38) in Figs. 13 through 16. The cost reference sheet (Fig. 13) shows the material quantities used, extended at a standard cost rate, to obtain total cost per thousand meals and a unit cost per meal. Fig. 14 compares for each item of material the actual consumption with the standard quantity. Fig. 15 is the card used to collect direct labor performance data for test periods to establish standard rates for each specific operation. Fig. 16 summarizes the variances at the end of each month.

COST REFERENCE SHEET

Menu No. 6 ________ Date ________

Meals Produced: 1000

		Quantity		Cost Analysis		
Ingredient:	Unit	Raw	Cooked	Unit Cost	Total Cost	Cost per Meal
Beef	lb.	400	330	$.48	$192 00	$.19200
Potatoes	lb.	230		.06	13.80	.01380
Lima Beans	lb.	150		.16	24.00	.02400
Butter	lb.	11		66	7.26	.00726
						$.xxxxx
Packaging Supplies:		Quantity				
Aluminum trays		1,009		$60.00 M	$ 60.54	$.06054
Aluminum overwrap		1,013		12.00 M	12.16	.01216
						$.xxxxx
Direct Labor:						
Preparation						$.07134
Assembly line						.03642
Wrapping						.02140
						$.xxxxx
Total						$ xxxxx

Fig. 13. Cost reference statement.

MATERIAL RECORD CARD

Item: Lima Beans   Grade: "A"   Unit: lb.   Standard Cost: $.16

Standard consumption per 1,000 meals: Menu No. 1 ____ Menu No. 3 200 Menu No. 5 ____ Menu No. 7 ____

Menu No. 2 ____ Menu No. 4 ____ Menu No. 6 150 Menu No. 8 ____

Vendors: A. Grow Pak, Inc.   B. Freeze Fresh Corp.

Received			Production		Consumption		
Date	Vendor	Quantity	Menu No.	Meals	Standard	Actual	Variance
1/1	Inventory	6,500	3	62,000	12,400		
1/5	B	30,000	6	45,000	6,750		
1/31	Total	36,500			19,150	19,500	Plus 350 lb.
2/1	Inventory	17,000					(Jan. ___)

Fig. 14. Record card for each individual material.

Direct Labor Report

Preparation ______________ Date: ______________

Operation: Breading Veal Menu: No. 2 Meals Prepared: 1,830

Class of Labor	Number of Employees	Time From	Time To	Hours	Total Man Hours	Average Rate	Office Use Cost
(a)	2	8:00 AM	10:00 AM	2	4	$1.50	$ 6.00
(b)	3	8:00 AM	11:00 AM	3	9	1.75	15.75
(c)	2	10:00 AM	11:30 AM	1½	3	1.90	5.70
							$27.45

Unit cost of operation per meal .... $ .015

Fig. 15. Labor record for each operation.

Monthly Variance Summary

	Standard	Price Variance *	Use Variance	Actual
Raw materials consumed ...	$—	$—	$—	$—
Packaging supplies	—	—	—	—
Direct labor	—		—	—
Indirect labor	—		—	—
Factory overhead	—			—
Cost of goods manufactured	$—			$—

* **Note:** Detailed analyses of variances illustrated above or supplementary reports are prepared for management.

Fig. 16. Monthly summary of variances prepared for management.

Statements Stressing Unit Costs. The ice cream division of the Stroh Brewery Company has monthly statements which stress the importance of unit cost, although these statements are not complex from a process cost point of view. Figs. 17 through 20 are adapted from statements of this company.

THE STROH BREWERY COMPANY
ICE CREAM MANUFACTURING COSTS
September 19__

	Month (cents per gal.)	To Date (cents per gal.)
Materials		
Salaries and Wages:		
Superintendence		
Mixing, freezing, packaging and loading		
Overtime premium		
Vacation and holiday pay		
Payroll taxes		
Compensation insurance		
Group insurance		
Salaried employees pension		
Total salaries and wages		
Other expenses:		
Cartons and wrapping materials		
Miscellaneous supplies		
Materials storage		
Uniforms		
Water		
Electricity		
Miscellaneous		
Repairs and maintenance		
Depreciation, building		
Depreciation, equipment		
General plant and maintenance, prorated		
Refrigeration, prorated		
Steam		
Total other expenses		
Total manufacturing expenses		
Ice cream manufactured (gal.)		

Fig. 17. Monthly manufacturing cost statement.

THE STROH BREWERY COMPANY
ICE CREAM MANUFACTURING
September 19__

Operating Statement

Month (cents per gal.)			Year to Date (cents per gal.)
		Gross sales:	
______	......	Less rebates	______
		Net sales:	
______	......	Less cost of goods sold	______
______	......	Gross profit	______
		Expenses:	
		Delivery ______	
		Selling and Adv. ______	
______	......	Total	______
______	......	Operating profit	______

Cost of Goods Sold

Month			Year to Date	
Cents per Gal.	Gallonage		Cents per Gal.	Gallonage
______	______	Manufacturing beginning inventory	______	______
______	______	Less ending inventory	______	______
______	______	Specialties, ice cream purchased ..	______	______
______	______	Sold	______	______

Fig. 18. Monthly operating statement with supporting schedule of cost of goods sold.

The Stroh Brewery Company
Ice Cream Delivery Expenses
September 19__

	Month (cents per gal.)	To Date (cents per gal.)
Labor:		
Drivers		
Commissions		
Platform and checking		
Office		
Overtime premium		
Vacation, severance, and holiday pay		
Payroll taxes		
Compensation insurance		
Group insurance		
Total labor		
Other expenses:		
Dry ice		
Sales tickets and printed forms		
Uniforms		
Drivers' phone calls		
Miscellaneous		
Garage, prorated		
Total other expenses		
Total delivery expenses		

Fig. 19. Schedule of delivery expenses per unit.

THE STROH BREWERY COMPANY
ICE CREAM SELLING, ADVERTISING AND REFRIGERATION EXPENSES
September 19__

	Month (cents per gal.)	To Date (cents per gal.)
Labor:		
Supervision and salesmen's salaries		
Ice machine repairmen		
Vacation, severance, and holiday pay		
Overtime premium		
Payroll taxes		
Compensation insurance		
Group insurance		
Salaried employees' pension plan		
Total labor		
Refrigeration expenses:		
Cabinet rentals		
Ice machine supplies		
Outside refrigeration service		
Depreciation, building		
Depreciation, equipment		
Depreciation, ice machines		
Depreciation, fountains		
Uniforms		
Truck and garage, prorated		
Total refrigeration expenses		
Selling and advertising expenses:		
Salesmen's expenses		
Sales promotion		
Window lettering		
Point of sales and illuminated signs		
Outside signs and bulletins		
Tickets, programs, and contributions		
Miscellaneous		
Total selling and advertising expenses		
Total selling, advertising, and refrigeration expenses		

Fig. 20. Monthly per-unit cost statement for certain specified activities.

The illustrations in this section demonstrate the wide variety of reports used in process cost situations. A common element in many of these is the showing of unit costs as an aid to control. For a general discussion of the important factors in designing, issuing, and interpreting reports for effective utilization by the various levels of management, see the section on Cost Control, Budgets, and Reports.

SECTION 13

JOINT COSTS

CONTENTS

CONTENTS (*Continued*)

SECTION 13

JOINT COSTS

Joint Costs and Products

CHARACTERISTICS. Multiple-product production is characteristic of American industry. Common input cost factors for multiple products in both manufacturing and distribution are widely prevalent. Although there is general applicability of concepts to both these areas, this section is concerned primarily with manufacturing costs.

Total costs of production of multiple products involve both common and separable costs. The **separable costs** are readily identified with individual products and offer no particular problem. The **common costs** cannot be readily identified with individual products and are generally allocated. According to NAA Research Series No. 31, Costing Joint Products, "Costs may be common not only as to products but also as to periods of time, responsibilities, sales territories, classes of customers, and other costing units." Costs that are common as to products are the main concern of this section. Such common costs consist of (1) those recurring fixed costs that are incurred regardless of the level of product output, (2) those costs generally identified with periods rather than products, and (3) those costs of production that vary with product output but cannot be traced directly to individual products. Procedures dealing with **variable product costs** (both direct and indirect) are discussed also in several other sections.

The term **joint cost** is frequently used synonymously with common costs of product. When used in this sense, the term is broader than that ordinarily used in accounting and economic literature. Technically, three distinguishable situations with respect to **product** are encompassed under these broad concepts. First, **true joint-cost** products are products that of necessity must be produced together and have a definite quantitative relationship to each other such that an increase in the output of one increases the output of the others, although not necessarily in the same ratio. These true joint-cost products are in essence **complementary products.** The quantitative relationship between them may be **fixed** and invariable (for example, as in hides and meat) such that an increase in the output of one product will not change the proportionate output of the other product, or it may be **variable** to a greater or lesser degree. At the extreme in variability of proportions, costs no longer are joint. Second, products may be produced simultaneously from common costs but may be **substitute** or **alternative** products, such that an increase in the output of one will inevitably result in a decrease in output of the others, although not necessarily in the same proportion. Third, products may be produced together simply for **economic reasons** (it being cheaper to produce the products jointly rather than separately) without there being any real relationship between the products.

Role of Joint Costs in Industry. A recognition of the nature of the cost under consideration is essential to its allocation and use in differing circumstances.

In addition to inventory pricing, **product cost allocations** are necessary to provide figures for many **managerial decisions.** Some of the decisions for which product costs may be necessary include the following:

1. Inventory pricing.
2. Matching costs with revenue obtainable from product.
3. Determining and appraising efficiency.
4. Internal control.
5. Setting price and price structure of products.
6. Setting up relative outputs of product and modifications thereof.
7. Problems of special lots or orders including government cost-type contracts.
8. Price "justification" for legislative or administrative regulations.

While these types of decisions are not meant to be exhaustive, they are indicative of the range of problems encountered.

One of the problems of the production engineer is the complete utilization of the **raw material.** An inevitable accompaniment of the production process is the appearance of **waste** and **scrap.** The trend of modern production is all in the direction of the elimination of such waste and the obtaining of a 100 percent yield from the raw material. Such yield may not be all in the form of one product, but the effort of management is directed toward obtaining 100 percent utility, if necessary through a variety of products, each of which represents an economic and commercially useful item. For instance, the wood distillation process, first introduced by the Ford Motor Company, uses sawdust and waste wood and produces valuable by-products, such as charcoal, hardwood pitch, wood creosote oil, calcium acetate, ethyl acetate, and wood alcohol. Competition forces utmost utilization of raw material The importance of by-products and joint products analysis is not always evident, particularly where the minor products have little value and **profit margins** on the major product are satisfactory. The continued drive for greater utilization in the production process has emphasized the importance of adequate accounting for joint costs.

Prevalence of Joint Costs. Joint costs usually are found in those industries in which one raw material is the source of several products. These industries, usually designated as **basic industries,** are typified by the meat packing, chemical and oil products, and other extractive industries. These and similar industries are characterized as predominantly users of **process cost** accounting systems. Job order cost systems are usually not found in joint cost industries. It may be necessary from time to time, however, to make common cost analyses in **job-cost** type industries.

According to Vance (Theory and Technique of Cost Accounting), "Joint costs are prominent in extractive, agricultural, and chemical industries." Examples of **joint products** and **by-products** from these industries are given by Vance in the tabulation on the following page.

Other instances of joint products occur in industries where different **grades** of the same product are obtained, as in the lumber milling, paper products, and fruit canning industries.

DEFINITIONS AND EXAMPLES. The following definitions are in general use, and the examples serve to illustrate their nature.

Joint Costs and Common Costs. Kohler (Dictionary for Accountants) defines **joint cost** as, "The common cost of facilities or of services employed in the output of two or more simultaneously produced or otherwise related operations, commodities, or services." Likewise, NAA Research Series No. 31, Costing Joint

Industry	Joint and By-products
Agricultural and food industries:	
Flour milling	Patent flour, clear flour, middlings, bran, wheat germ.
Meat packing	Meat, hides, fertilizer, shortening, hair, and many other by-products.
Cotton ginning	Cotton fiber, cotton seed.
Fishing	Fresh fish, canned fish, fish meal, fish oil, fertilizer.
Cottonseed processing	Cottonseed oil, meal, hulls, and linters.
Dairy products	Cream, skim milk, butter, ice cream, and other products.
Extractive industries:	
Copper mining	Copper, gold, silver, and other metals.
Sawmill operation	Several grades of lumber, slabs, sawdust.
Petroleum refining	Naphtha, gasoline, kerosene, diesel and fuel oils, paraffin, tar, and many other products.
Gold mining	Gold, silver, copper, and other metals.
Chemical industries:	
Soap making	Soap and glycerine.
Coke manufacture	Coke, ammonia, coal tar, gas, benzol, and other products.
Manufactured gas	Gas, coke, ammonia, coal tar, and sulfur compounds.

Products, states, "Costs are joint when two or more distinguishably different products are produced together from a single input cost factor. The characteristic condition of a joint cost is that the cost of several different products is incurred as a lump sum for the combination and not separately for the individual products."

Common costs are used synonymously with joint costs by NAA Research Series No. 31, Costing Joint Products, but Kohler (Dictionary for Accountants) distinguishes them. Kohler defines common cost and distinguishes it from joint cost as, "The cost of facilities or services employed in the output of two or more operations, commodities, or services. Thus the premium paid for a fire-insurance contract covering unrelated lots of merchandise in a warehouse is a common cost. . . . insurance and other common costs applicable to a number of unrelated items are often treated as a period cost. Common costs of related outputs are known also as joint costs." According to this widely held viewpoint, joint cost is a special type of common cost.

Vance (Theory and Technique of Cost Accounting) uses the terms as mutually exclusive. He defines **common costs** as, ". . . the costs of producing two or more separate (not joint) products with the same facilities at the same time." Further, Vance states,

> Common cost and joint costs . . . have an important difference: common costs can be traced to the separate products on a cause-and-effect basis or by tracing the use of facilities; they do not include direct materials and labor . . . whereas joint costs cannot be so traced and do include the prime costs. The machine time, building space, and other factors can be determined separately for 1-inch hose as against ¼-inch tubing because either can be made without the other, but the feed necessary to produce beef cannot be distinguished from that required to produce the cowhide.

Joint Products. Joint products are likewise defined in both the broad and narrow sense. *Economists and accountants generally define joint products as distinguishably different products which are inevitably produced together from the same raw material.* Thus Matz–Curry–Frank (Cost Accounting) state,

Accepted accounting terminology refers to joint products as products that are produced simultaneously by a common process or series of processes, with each product possessing more than a nominal value in the form in which it is produced. The definition emphasizes the point that the manufacturing process creates the products in a somewhat definite quantitative relationship. An increase in the output of one product will bring about an increase in the quantity of the others, or vice-versa, but not necessarily in the same proportion.

Recently there have been attempts, notably by the NAA (NAA Research Series No. 31, Costing Joint Products), to broaden the concept to include as joint products all products jointly produced, as shown in the following definitions:

The products in a jointly produced group often vary in importance. Products of greater importance are termed **major products** and products of minor importance are termed **by-products.** Where two or more major products appear in the same group, they are called **co-products.** The term **joint product** is applied in this report to include major products, by-products, and co-products because all are jointly produced.

This NAA Research study says that its own definition of joint products

is broader than that ordinarily found in accounting literature where the costing of joint products is usually discussed as a special problem, arising in industries which split raw materials into different products. However, observations show that jointly incurred costs occur in practically every industry even though they may not be recognized as such.

Major Products. The term "joint product" is also commonly used as an opposite to by-product. Thus Schlatter and Schlatter (Cost Accounting) emphasize that both **by-products** and **joint products** are the inevitable results of joint processing, and that the only distinction between them is in their relative values, with joint products having more nearly the same importance and values relative to each other than by-product and main product. As indicated above, NAA Research Series No. 31, Costing Joint Products, and some other current writers prefer to term jointly produced products of greater economic importance as **major products** and those of lesser importance as **minor products.** Major products are also known as **main products** or **prime products.**

Co-products. "Where two or more major products appear in a jointly produced combination, these products are called 'co-products' to indicate that they are products of like importance together," according to the same NAA Research Study. Schlatter and Schlatter (Cost Accounting), however, distinguish co-products from joint products because in the case of co-products no item is inevitably the result of the production of the others.

Minor Products. All jointly produced products of lesser economic significance are termed "minor products."

By-products. Neuner (Cost Accounting) indicates that by-products are produced from the same process as joint products but that the by-products are essentially the secondary results of the operation. He states, "A rather arbitrary rule has been suggested in interpreting the meaning of 'secondary'—if the value

of a product is less than 10 percent of the total value of all products, it could be considered a by-product, not a co-product or joint product."

Schlatter and Schlatter (Cost Accounting) emphasize that by-products split off from the original material in process and thus do not become part of the main product. In some industries by-products are known as **recoveries.**

Scrap. When the value of the by-product is small relative to the major product and it is recoverable without further processing, it is generally called "scrap" or "waste." To avoid confusion with other uses of the word "waste" (see section on Materials), it seems preferable to use the term **waste material** rather than "waste."

Spoiled and Defective Work. According to Devine (Cost Accounting and Analysis), spoiled and defective work are distinguishable. Spoiled work can be sold more profitably as **seconds** or imperfect stock, while defective work may often be perfected by further applications of labor and other services. A normal amount of scrap involves no special accounting since it is usually regarded as a proper charge to production. Abnormal or excess spoilage calls for charges to a **waste** or **spoilage account.**

DIFFERENTIALS. When two or more jointly produced products can be produced in varying proportions, or are not inevitably produced together, it is possible to determine the **differential cost** of each by varying the output of one or the other product. In essence this procedure is possible for all **substitute** or **alternative** products, although the cost of the determination may make it uneconomic to use it.

For example, assume that two products, A and B, are jointly produced at a total cost of $100 in the physical **product proportions** of 40 to 60, respectively. If the proportions are changed to 50 to 50, and total common costs increase to $120, a separate cost can be computed for A and B as follows:

At 50 to 50 output,

$$\text{Differential cost of ten extra A's} = \$20 + 10\text{ B's}$$

And as total cost is,

$$50\text{ A's} + 50\text{ B's} = \$120$$

Substituting,

$$50\text{ A's} = 5\ (10\text{ A's}) = 5\ (\$20 + 10\text{ B's})$$

We get

$$5\ (\$20 + 10\text{ B's}) + 50\text{ B's} = \$120$$

$$\$100 + 50\text{ B's} + 50\text{ B's} = \$120$$

$$100\text{ B's} = \$120 - \$100 = \$20$$

$$\text{Cost of 50 B's} = \$10$$

$$\text{Cost of 50 A's} = \$110$$

Again, if the total costs remain the same with a change in product proportion, a more direct approach can be used. If, in the preceding example, no change in total costs took place, we would get a direct substitution of $10\text{ A's} = 10\text{ B's}$; therefore the cost of A would equal the cost of B, and cost would be split proportionately.

The **replacement cost** method used in petroleum refining is a variant of this. It is discussed in detail later in this section.

Joint Product Accounting

MAJOR FUNCTIONS. Cost allocations to product are vital to various managerial decisions. The bulk of these are discussed later in this section under Joint Cost Analysis and Managerial Decisions. **Accountants** chiefly are concerned in determining inventory figures for joint products to be used in connection with periodic **income statements** and **balance sheets.** Joint overhead costs which represent the costs of services to be apportioned to various departmental accounts are discussed in more detail in the section on Distribution of Manufacturing Overhead.

Process Costs. In many cases both co-products and by-products result from a joint operation, and both **by-product** and **co-product methods of allocation** are used to allocate joint costs to individual products. When this is the case, even though process accounts for joint costs may be kept in the general ledger or in the factory ledger, it is generally inconvenient to do so because of the allocation problem. Thus, according to Schlatter and Schlatter (Cost Accounting) it may be better to open only one **manufacturing account,** to which all costs are debited and to which costs allocated to several products are credited. Individual process costs can then be maintained on separate **cost cards** outside the ledger. In such cases Schlatter and Schlatter state (Cost Accounting), "The purpose of process costs, when such costs are joint, is not to find separate costs of the individual products but rather to find the total cost of all products and individual operating costs of each process."

Methods of Costing and Valuation. In attempting to develop proper methods of joint-product accounting, the following points must be given consideration:

1. Methods of determining cost of co-products.
2. Methods of determining cost of by-products.
3. Valuation of by-products.
4. Valuation of inventory of by-products and co-products.

METHODS OF JOINT PRODUCT ACCOUNTING. Joint product accounting, as noted by Schlatter and Schlatter, may involve costing and valuation of both **major** and **minor products.** Generally the problem is restricted to costing and valuation of co-products and by-products of significant value. Cost accounting is here concerned with costs incurred at two stages, after and prior to the split-off point.

Costs Incurred After the Split-off Point. Costs incurred after the split-off point are **separable costs** and can therefore be directly attached to individual products in the usual manner. It is immaterial whether they are co-products or by-products; after the split-off point they are **independent products,** and costs independently incurred should attach directly. Some writers, however, maintain that costs incurred after the split-off point on joint products should earn the same **gross profit rate** as those costs incurred prior to split-off, and that the gross profit rates on the joint products should be the same. This procedure treats costs incurred after split-off as actual joint costs. For example, Lorig (Accounting Review, vol. 30) states,

In effect, the costs incurred up to the split-off point and the separate processing costs incurred afterward up to the point where sales values are determined are all joint

costs. . . . Therefore each dollar invested in such costs must logically be assumed to be equally profitable.

This approach is not followed generally.

Costs Incurred Prior to the Split-off Point. Costs incurred on joint products prior to the split-off point by definition cannot be traced directly to individual products. A suitable **basis for allocation** of such costs is therefore necessary. Thus Vance explains (Theory and Technique of Cost Accounting), "Many efforts have been made to 'trace' costs of joint products individually before separation, but this serves no managerial purpose because no decision to modify or cease production of one product can be made independently of the others." Similarly, Schlatter and Schlatter (Cost Accounting) state:

When products are produced jointly, that is, when one cannot be produced without the others, separate **true costs** for each cannot be found. In fact, there are no **separate costs** for the several products. True joint cost for all may be compiled, but this total cost cannot be accurately divided among the several products. If allocation is required, it must be made arbitrarily, yet as reasonably as possible.

Allocations of Joint Costs. Allocations of joint costs attributable to minor products, especially by-products, are discussed later in this section under By-product Accounting. Allocations of joint costs attributable to **co-products** up to the split-off point are discussed here.

NAA Research Series No. 31, Costing Joint Products, lists two principal **types of bases** for allocating common costs to co-products; these can be distinguished as:

1. Bases assumed to measure benefits which individual co-products receive from common cost factors.
2. Bases assumed to measure ability of individual co-products to absorb joint costs.

METHODS OF ALLOCATING JOINT COSTS. Generally speaking, five basic methods are used in allocating joint costs to co-products up to the split-off point:

1. Average unit cost.
2. Apportionment on the basis of some physical unit, such as weight, volume, linear measure, atomic weight, and heat units.
3. Weighted average methods, predetermined or standard rates, and index of production.
4. Apportionment on the basis of relative market values of the individual products.
5. Standard cost method.

NAA Research Series No. 31, Costing Joint Products, indicates the majority opinion on the subject of allocating joint costs:

To some extent all methods of allocating joint costs to individual co-products rest upon opinion rather than upon objective measurements. In the words of one company representative, "It is possible to determine **a cost**, but there is no way to determine **the cost** of a co-product." Where the method for determining product costs is thus subjectively determined, equally competent accountants may arrive at quite different costs for the same product, and there is no way to prove that one cost is more correct than another. Evidence of this was seen in the field study where different companies making the same products by the same processes often reported different bases for cost allocation. Moreover, in virtually every company differences of opinion arise with regard to how to allocate costs.

Keller (Management Accounting for Profit Control) however, states, "There are many acceptable methods for costing by-products, but there is only one generally accepted practice of costing joint [co-]products." This method, according to Keller, is to allocate the costs of production on the basis of the **sales price** which will be realized on each product. In view of the differing decisions for which cost allocations must be made and the widespread use of the various methods of cost allocation found in practice and in the literature, Keller's single-method contention appears to represent a minority viewpoint. If the cost allocation were to be used for pricing individual products, this method would be circular.

AVERAGE UNIT COST METHOD. Under this method total costs only are figured, yielding an average unit cost and one net profit. Thus average costs are obtained for the production as a whole. This method is valid only in those cases where the resultant products are expressed in terms of the same units. Where the units are not comparable, the method breaks down at once.

The average is used for **inventory pricing** purposes, but it may also be used for the purpose of **allocating joint costs,** each product being valued at the average cost in proportion to the quantities produced.

Although the method is not wholly satisfactory, it has a measure of logic behind it. Since all products are turned out by the same process, it is impossible to say that one costs more to produce per unit than the other.

The method has been sanctioned by the Internal Revenue Service in the following ruling:

> . . . Tobacco companies taking inventory on the monthly average cost method, no method more nearly approaching theoretical accuracy being possible, may continue to use such method in reporting for income tax . . .

An example taken from the operations of a sawmill illustrates the method:

1. Total production .... 2,500,000 ft.
2. Total cost (joint) $53,000.00
3. Average cost per 1,000 ft. .... $ 21.20

This average is used to cost the various grades produced in proportion to their quantities:

Grades	Quantities Produced (Ft.)	Average Cost per 1,000 Ft.	Value of Product
First and seconds	250,000	$21.20	$ 5,300.00
No. 1 common	1,250,000	21.20	26,500 00
No. 2 common	500,000	21.20	10,600.00
No. 3 common	500,000	21.20	10,600.00
Totals	2,500,000		$53,000.00

Application of Average Cost Method. The tobacco and lumber industries are examples of where the average cost method may be employed. Simpson (Journal of Accountancy, vol. 104) states that, "Most operators (manufacturers of forest products) assign an over-all average cost per thousand board feet to the logs entering the mill and add to this an over-all average conversion cost to arrive at an average finished product cost which is applied to all finished products irrespective of their type, grade, or market value." These costs are not for setting prices

and would have serious limitations for this, as well as being of limited value otherwise. Thus Simpson explains,

Where the average cost procedure is followed, the company may show a profit margin of 200 percent to 300 percent on the top grades produced and a loss of 40 percent to 50 percent on the lower grades. To cite a typical example, a particular company priced its 1955 output at an average cost of $70, although the selling prices of this output ranged from $265 for Number 1 and Number 2 clear down to $45 for Number 4 common. It is obvious that the over-all average cost method is of little value to the operator in planning and directing the operations of his mill. Where this method of costing is used, the operator has to rely on experience and rule-of-thumb methods to determine what logs to cut and what types and grades of products to produce. Nevertheless, the great majority of operators in the industry use the over-all average cost method for want of a better one.

Flour milling, the making of glue, and in fact all industries in which **different grades** of the same product are produced by a single joint process offer the possibility of the use of the average cost method.

ALLOCATION ON PHYSICAL UNIT BASIS. Under this method joint costs are distributed to products on the basis of some physical coefficient, i.e., the joint cost is broken up in proportion to the **raw materials** contained in each product. These **physical coefficients** may be expressed in such terms as weight, volume, linear measure, atomic weight, and heat units. If the joint products are not directly measurable, some common denominator may be used. For example, in winery accounting, the various quantities, tons, gallons, cases, etc., are reduced to a common denominator, **proof gallon.** Maxwell (Winery Accounting and Cost Control) describes a procedure whereby proof-gallon equivalent is used in the winery industry as a **control device,** although book costing is done in terms of another physical unit, wine gallons.

Applications of Physical Unit Method. The following example of the use of this method is given by Lang–McFarland–Schiff (Cost Accounting) with reference to the manufacture of coke, wherein the costs may be allocated in proportion to the weight of product per ton of material, in this case, coal. In the accompanying tabulation, the weights of all finished products (except gas) are determined per ton of coal, and the sum of these is subtracted from 2,000 pounds to obtain the weight assigned to the gas. The computations shown in the table are based on a cost of $8 per ton of coal.

SCHEDULE SHOWING APPORTIONMENT OF MATERIAL COST VALUE TO EACH PRODUCT PER TON OF COAL

	Yield in Lb. of Recovered Products per Ton of Coal	Distribution of Waste to Recovered Products (Lb.)	Revised Weight of Recovered Products	Material Cost of Each Product on Basis of Weight
Coke	1,320.0	69.47	1,389.47	$5.56
Coal tar	120.0	6.32	126.32	.50
Benzol	21.9	1.15	23.05	.09
Sulphate of ammonia..	26.0	1.37	27.37	.11
Gas	412.1	21.69	433.79	1.74
Waste (water)	100.0			
Total	2,000.0	100.00	2,000.00	$8.00

Cost per pound: $8 ÷ 2,000 = $.004

Another illustration is that of a joint cost distribution on the basis of atomic weights. It can be applied, for example, to the electrolytic soda-chlorine-hydrogen process. The chemical reaction represented by the process is:

$$\mathrm{NaCl} + \mathrm{H_2O} = \underset{23}{\mathrm{Na}}\ \underset{16}{\mathrm{O}}\ \underset{1}{\mathrm{H}} + \underset{35}{\mathrm{Cl}} + \underset{1}{\mathrm{H}}$$

The figures under the symbols on the right-hand side of the chemical equation represent atomic weights. Barring moisture and impurities, the end products are produced in ratio of 40 pounds of caustic soda (NaOH), 35 pounds of chlorine, and 1 pound of hydrogen. The joint costs may thus be allocated between the soda and chlorine on the basis of their atomic weights.

The physical unit method attempts to cost according to the **benefit** received from each of the end products. Thus each unit of raw material in final product is presumed to cost just as much to produce as any other. This is especially true where the dominant element can be traced to product. According to Vance (Theory and Technique of Cost Accounting), "this method is generally unsatisfactory, however, because it ignores two important facts: (1) not all costs are directly related to physical quantities, and (2) some of the product might not have been handled at all if it were not physically inseparable, up to a certain point, from the part desired."

WEIGHTED AVERAGE METHODS. In an attempt to overcome the difficulties encountered under both the simple average and the physical unit methods, weight factors are often assigned. These **weight factors** may include such diverse elements as amount of material used, difficulty of manufacture, time consumed, and difference in type of labor used. These factors and their relative weights are usually combined in a single value, called the **factor of conversion.** In the canning industry, the weight factor is given effect in the calculation of a **basic case.**

Applications of Weighted Average Methods. In the following example, taken from Matz–Curry–Frank (Cost Accounting), the composite weight factor is given in terms of **points,** and the cost allocation is then made on the basis of **equivalent units.** In this example, cost per unit would be $2 ($120,000 ÷ 60 000 units), but the cost per equivalent unit is $0.30 ($120,000 ÷ 400,000 units) and the assigned costs are materially changed:

Product	Units Produced	Weight Points	Equivalent Units	Cost per Equiv. Units	Cost Assigned
A	20,000	10	200,000	$.30	$ 60,000
B	15,000	8	120,000	.30	36,000
C	10,000	5	50,000	.30	15,000
D	15,000	2	30,000	.30	9,000
Totals	60,000		400,000	$.30	$120,000

In some instances the weight factor is strictly a quantitative conversion factor, while at the other extreme the weight factor will reflect purely sales values or net sales values. If only the latter is used, the method approximates the allocation of joint costs on the basis of selling prices alone. The selling price method of joint-cost allocation is discussed later in this section.

In the canning industry both **quantitative** and **qualitative factors** are used in allocating joint costs of several grades of a canned product. Fig. 1 is used by

Jankowski (NAA Bulletin, vol. 36) to illustrate this point in a typical basic case computation. The quantitative cases are used to allocate direct-preparation labor costs and other costs directly related to the quantity of unprepared fruit in a particular size. The qualitative cases are used to allocate the purchase cost of raw materials to product. The totals applicable in each instance are divided by the total basic case to obtain the cost per basic case. This unit cost is then multiplied by the proper factors to obtain the unit cost for a particular actual case.

YELLOW CLING PEACHES

(A) Quantitative Cases

	Actual Cases Packed	Size Case	Factor	Cases, Basic 2½ Size
	100	48/8 oz.	0.60	60
	170	24/303	.57	97
	370	24/2½	1.00	370
	360	6/10	.91	327
Totals......	1000			854

(B) Qualitative Cases

	Cases. Basic 2½ Size	Grade	Factor	Cases, Basic 2½ Standard Grade
	50	Fancy	1.30	65
	460	Choice	1.15	529
	270	Standard	1.00	270
	74	Pie	.50	37
Totals......	854			901

Fig. 1. A basic case computation of joint costs.

Frequently a composite weight factor is **predetermined** and set up as part of either an **estimated cost** or a **standard cost** system. Standard costs and joint-cost analysis are discussed later in this section.

The use of carefully constructed **composite weight factors** and the resulting equivalent units enable the cost accountant to give more attention to several influences and therefore result in more accurate allocations. The real danger, of course, is that weights may be used that are either inappropriate in the first place or have become so through the passage of time. Obviously, if arbitrary rates are used, the resulting costs of individual products will be arbitrary. When common costs are allocated more or less arbitrarily after consideration of various factors, the method is also known as the **survey method.**

ALLOCATION ON RELATIVE MARKET VALUE BASIS. Many, if not most, cost accountants believe that joint costs should be allocated to individual products according to their ability to absorb joint costs. Some, like Keller (Management Accounting for Profit Control), assert it is the only method,

while others use it at least as a limiting case. For example, NAA Research Series No. 31, Costing Joint Products, states that, "In the study several company representatives commented that management generally questions the costing procedures where one or more co-products in a jointly produced group appear to be consistently unprofitable, while others are profitable." Underlying these assumptions is the theory that costs would not be incurred unless the jointly produced products would yield enough revenue to cover all costs plus a reasonable return. Inferentially, a **derived cost** that the purchaser of raw material and other joint costs is willing to incur for any individual product is obtained by the reverse approach of relating costs to sales values. Several variants of this method are found in practice.

Allocation on Basis of Selling Prices. As it works out in practice this is a weighted market value basis, since the market value of each product is the product of the weight or other quantity by the unit value. Under this method each product is charged for what the traffic will bear, since the higher the market value, the greater the cost charged against the product. On the other hand, fluctuations in the market value of any one or more of the end products automatically change the apportionment of the joint costs, though actually it costs no more to produce than before. As long as fluctuations in prices of the various products are synchronized (not necessarily in the amount, but in the rate of change) their respective costs remain constant. But with some products fairly stable and others fluctuating, the method breaks down.

Using the same example of lumber mill costs given in the preceding discussion of the average unit cost proration, the joint cost of $53,000 is distributed to the various grades on the basis of their market values or selling prices as shown in the computation here.

MARKET VALUE METHOD OF JOINT COST APPORTIONMENT

Grades	Quantity Produced (Ft.)	Market Value per 1,000 Ft	Total Market Value	Percent of Total Market Value	Prorated Cost	Cost per 1,000 Ft
First and seconds	250,000	$105 00	$ 26,250	17 65	$ 9,354 50	$37.42
No 1 common ..	1,250,000	70 00	87,500	58 82	31,174 60	24 94
No. 2 common ..	500,000	40.00	20,000	13.45	7,128 50	14 26
No 3 common ..	500,000	30.00	15,000	10.08	5,342.40	10 68
Totals	2,500,000		$148,750	100 00	$53,000 00	

Prorating Total Costs to Grades. A variant of the **market value method** is found in the glue industry, where the cost-finding procedures are designed to spread the profit or loss against the value assigned to the several products, adjusting these so that in total they represent the total cost or outlay. The effect is simply to allocate the total costs incurred to the various products on the basis of an allocation similar to the market value method. A quantity of raw material of known cost is put into process. The products from the cooking operations are the several "runs of glue." The first run is of the highest grade, has the highest market value, and costs the least. Succeeding runs require higher temperatures, cost more, and produce lower grades of products. It is entirely impractical to

attempt to determine the actual money cost of each skimming, and even if possible, such figures are meaningless because the effect is to show the lowest cost on the first grade of product and the highest cost on the lower grades, the last or poorest skimming having the largest cost. The procedure, therefore, is to determine the cost of all glue produced and to spread this total cost over the various grades on the basis of their respective tests of purity.

The test index is an indicator of the quality and therefore of the market value of each run or grade produced. Hence, multiplying the yield for each run by its test value is equivalent to multiplying it by the market value. The resulting figures, when reduced to percentages of totals, furnish the means for calculating the prorated costs. These are then reduced to a cost per hundredweight.

The most practical method in most cases appears to be that of combining the total cost of production of all grades obtained and then allocating this cost to the several grades in proportion to their relative values.

Sales Prices Less Cost to Complete Individual Product. This method is used whenever there is no ready market price for the individual products at the split-off point. In this case it is permissible to work back from sales prices to assumed values at split-off. Vance (Theory and Technique of Cost Accounting) recognizes two methods of accomplishing this:

1. Relative sales value for calculation is the selling price of individual products less costs to complete.
2. Relative sales value for calculation is the selling price of individual products less value added by completion.

These two methods are illustrated in Figs. 2 and 3, taken from Vance.

Article	(1) Sales Price	(2) Cost to Complete	(3) Value Before Completion (1) − (2)	(4) Number of Units Produced	(5) Value of Total Production (3) × (4)	(6) Total Cost to Split-off Point *	(7) Cost per Unit to Split-off Point †
1	\$41.00	\$10.00	\$31.00	1,000	\$31,000	\$13.475	\$13.48
2	30.00	10.00	20 00	2,000	40,000	17.386	8.69
3	10.00	2 00	8.00	500	4,000	1,739	3.48
Totals					\$75,000	\$32,600	

* 43 466 percent of value.
† 43.466 percent of value before completion.

Fig. 2. Allocation of joint costs on sales prices less cost to complete individual products.

The first method is quite common and simple to apply. The second, or **value-added method**, recognizes that costs incurred after the split-off point are part of the cost total on which profit is expected to be earned, and therefore it makes allowance for this profit. The method assumes a normal relationship between cost and the cost-created value. Since the examples are based on the same data, study of the two will reveal significant differences. The question is first whether there is a "normal relationship" between cost and value, and secondly, whether the relationship is necessarily the same for all products jointly produced before and after the split-off point. The practice of product-line pricing to meet com-

petition tends to make such assumptions invalid. Earley (American Economic Review, vol. 46) found that three-fourths of the companies responding in a survey did not try to maintain more or less equal margins between prices and full costs on their various products.

Article	(1) Sales Price	(2) Value Added by Completion			(3) Value Before Completion (1) − (2)	(4) No of Units Produced	(5) Value of Total Product to Split-off Point (3) × (4)	(6) Total Cost to Split-off †	(7) Cost per Unit to Split-off Point ‡
		Cost	Gross Profit *	Total					
1	$41.00	$10.00	$6.67	$16.67	$24.33	1,000	$24.333	$14,600	$14.60
2	30.00	10.00	6.67	16.67	13.33	2,000	26,667	16,000	8.00
3	10.00	2.00	1.33	3.33	6.67	500	3,333	2,000	4.00
Totals							$54,333	$32,600	

* Gross profit is 40 percent of sales or two-thirds of cost.
† 60 percent of value.
‡ 60 percent of value before completion.

Fig. 3. Allocation of joint costs on sales prices less value added by completion.

All **sales price methods** are subject to one compelling criticism. Where cost is determined by price, price cannot be determined by cost. Therefore, all sales price methods are **circular** for pricing decisions and inferentially so for many other types of decisions that have sales price as a fundamental factor.

Also, changes in relative market price reflect as changes in cost of product, although no change may have taken place in either total costs or methods of production. NAA Research Series No. 31, Costing Joint Products, reports that this has sometimes led to undesirable shifts in sales emphasis on selling prices. Further, the NAA research study reports that the method could mislead management if it created the impression that all products were equally profitable because they showed the same margin per dollar of allocated cost.

JOINT COSTING METHODS IN CRUDE OIL REFINING. The petroleum industry is one in which there are a number of difficult problems involving joint cost. According to Irving and Draper (Accounting Practices in the Petroleum Industry):

> . . . One of the major accounting problems facing the petroleum industry today is to devise an acceptable method of allocating costs between crude oil and natural gas. At this time, a generally accepted solution to the problem has not been determined, although many able and experienced accountants, engineers, economists, and lawyers are grappling with the problem.

The refining of crude oil into its major products (gasoline, kerosene, fuel oil, lubricating oils, asphalt, and coke) provides a good example of joint costs with variable proportions. History has shown that an increase in the facilities for refining gasoline adds to the production of the other products even though the proportions may be changed.

According to Griffin (Journal of Accountancy, vol. 105),

> In petroleum refining, the source of all finished production is the raw material, crude oil. For its refinement, numerous processing assemblies must be employed to effect

the production of requisite product volumes. Distillation units, cracking units, and alkylation and polymerization plants are but a few of the assemblies used to separate the hydrocarbon fractions in crude oil. Each of these units may be productive of as many as ten intermediate product streams, each of which may require extensive reprocessing, treating, or blending. The effect of this labyrinth of processing multiplies the difficulty of assigning raw stock and processing costs to refined products with dependable or acceptable accuracy.

Griffin notes that the costs of the crude petroleum and the blending stocks constitute approximately 75 to 80 percent of total refinery costs, with transforming or conversion costs aggregating 20 to 25 percent. The identity of these two cost elements from their inception until final assignment to refined products is generally preserved.

In spite of the complexity and difficulty of accurately computing the costs of each product, some attempt is generally made for costing the end products. Irving and Draper (Accounting Practices in the Petroleum Industry) state:

It is essential that a determination of the cost of individual products be made for purposes of inventory valuation, although the allocation of costs to individual products must necessarily be based on assumptions, in part, arbitrary. Many methods of allocating costs to individual products are in use, but probably no single one of them is found to be adequate in all situations.

After describing several methods of cost allocation in detail, Irving and Draper say, "In adopting these methods, a number of modifications and combinations have been devised by various companies to fit their own needs and specific situations." Among the methods in crude oil refining are various forms of joint-product and by-product accounting, the more important of which are described in subsequent paragraphs.

Average Unit Cost. The total raw material cost and processing expenses may be divided by the total yield to arrive at a uniform cost per unit of product. By this method some joint products bear too high a cost, others too little. Crude oil is bought on the basis of product content, a better price being paid for high gasoline content. This initial cost should be reflected proportionately in the end product if possible.

Sales Realization Method. According to Griffin (Journal of Accountancy, vol. 105),

The method most frequently used to cost refined products is variously referred to as the sales allocation, sales realization, or Federal Trade Commission method. It assumes that all products refined from crude petroleum are joint products and that each yields the same rate of profit. This assumption necessarily implies that the profit ratios for gasoline, kerosene, middle distillates, and lubricants are equivalent. In the application of this method, data must be accumulated on yields of the various grades of refined products, total crude and processing costs for the period under study, and the expected market realizations from the sale of each product. The relative market values of refined products provide the basis of assigning costs to the various product classes. Unit realizable values have, on occasions, been employed as a basis for cost distribution, but more often these values have been weighted by the volumes produced.

In Fig. 4(a) sales realization costing is illustrated. In Figs. 4 and 5, crude oil is assumed to cost $3.45 per barrel, and processing cost to produce the indicated volumes of finished products is assumed to be $0.95 per barrel.

Products	Barrel Yield	Estimated Realizations		Multiplier	Allocated Costs
		Per Barrel	Total		
Aviation gasoline	8,000	$ 6.25	$ 50,000	50/460	$ 47,826
Motor gasoline	42,000	5.00	210,000	210/460	200,870
Kerosene	10,000	4.40	44,000	44/460	42,087
Distillate fuels	20,000	4.00	80.000	80/460	76,522
Lubricants	5,000	10.00	50,000	50/460	47,826
Residual fuels	10,000	2.60	26,000	26/460	24,869
Gases and loss	5,000				
Totals	100,000		$460,000	460/460	$440,000

(a) Sales Realization Costing.

Products	Barrel Yield	Yield, Percent	Gravity	Barrel Gravity Factor *	Barrel Gravity, Percent	Allocated Cost per Barrel
Motor gasoline ...	50,000	50	50	2,500	69.44	$3.06
Kerosene	15,000	15	40	600	16.67	.73
Fuel oil	25,000	25	20	500	13.89	.61
Gases and loss	10,000	10				
Totals	100,000	100		3,600	100.00	$4.40

* Yield percent multiplied by specific gravity.

(b) Barrel Gravity Method.

Products	Barrel Gravity, Percent	Allocated Crude Costs	Heat Units, Percent	Refinery Processing Costs	Assigned Product Costs per Barrel
Motor gasoline ...	69.44	$2.40	40	$0.380	$2.780
Kerosene	16.67	.57	10	.095	.665
Fuel oil	13.89	.48	50	.475	.955
Gases and loss					
Totals	100.00	$3.45	100	$0.950	$4.40

(c) Gravity-Heat Unit Method.

Total refinery costs				$440.000
Products	Barrel Yield	Estimated Realizations: Per Barrel	Estimated Realizations: Total	
Aviation gasoline	8,000	$ 6.25	$50,000	
Kerosene	10,000	4.40	44,000	
Distillate fuels	20,000	4.00	80,000	
Lubricants	5,000	10.00	50,000	
Residual fuels	10,000	2 60	26,000	
Gases and loss	5,000			
Totals	58,000			250,000
Net cost motor gasoline ...	42,000			$190,000

(d) By-product Costing.

Fig. 4. Multiple-product costing methods in the crude oil industry.

According to Griffin, the underlying premise upon which this method rests is fallacious in is application to much of refinery costing. He says,

Few products refined from crude petroleum yield the same rate of profit; indeed, modern refineries produce substantial quantities of specialty products, whose actual manufacturing costs are obscured by this type of distribution. For those refineries, however, producing principally motor gasoline, kerosene, furnace, and fuel oils, the method may be used without distorting operating results materially.

Barrel Gravity Method. Since crude oil cost is dependent to a large extent on its content, the higher the yield, the better the price paid for it. Some companies recognize this and take it into account in apportioning the joint production costs. The technique is similar to the **weighted selling ratio method**; i.e., instead of using realized market values as a basis for the cost distribution, barrel gravity is substituted. Fig. 4(b), adapted from Griffin, cited before, illustrates the procedure.

The barrel gravity method is simple. It has been criticized, however, on the ground that the resulting prorated costs are not accurate because the correlation between the weighting factors and actual cost is not perfect. According to Griffin (Journal of Accountancy, vol. 105), "Formerly this correlation may have been significant, but it is presently regarded as slight."

Gravity-Heat Unit Method. Under this method only the crude oil costs are distributed on the basis of gravity content. To these costs are added the refinery operating expenses distributed on the basis of the heat units applied. The heat units are expressed as a percent of the total heat units applied to obtain each product from the distillation process, as shown by records kept for that purpose. Griffin shows the results in Fig. 4(c), using the same basic data as before. The use of barrel gravity for distributing crude oil cost is open to the same objection as in the preceding illustration, in that it assumes that the gravity of each product manufactured bears a direct relation to the gravity of the raw material. Also, since crude oil costs are so large a part of total refinery costs, only a small portion of product cost makes use of the heat-unit factor. It appears that neither the barrel gravity method nor the gravity-heat unit method is widely used.

By-product Method. In this method the market value of by-products such as kerosene is deducted from the crude oil cost, including operating expenses. The resulting figure represents the cost of producing gasoline, which is thus ordinarily treated as the major product. Fig. 4(d), taken from Griffin, illustrates this method. Griffin notes that the by-product method has declined in importance as a costing device because modern refineries aim to produce many different products at a profit, rather than a single main product. The by-product method remains in use to a limited degree, largely for special purposes. Irving and Draper (Accounting Practices in the Petroleum Industry) comment that the by-product method is used "where gasoline is the most desired product, and is based on the theory that the refinery operates primarily to produce gasoline. . . . Some feel that this method of cost finding may be misleading because selling prices are seldom, if ever, governed by costs."

Replacement Value Method. This method is based on the assumption that motor gasoline is the most important refinery product manufactured and that its cost should be determined as independently as possible of other product costs. The other co-products have a **potential gasoline yield** and are valued at the cost of this potential gasoline minus what it would cost to convert these products into gasoline. According to the Committee on Price Determination (Cost Be-

havior and Price Policy, National Bureau of Economic Research), "There can be no doubt that costing of gasoline by the replacement value method provides the closest approximation to the correct economic allocation of joint cost under varying proportions of any of the accounting methods in general use." This method

Step 1. Actual Production

Products	Barrel Yield	Percent Yield from Crude Oil
Motor gasoline	50,000	50
Kerosene	10,000	10
Distillate fuel and lube	25,000	25
Fuel oil	10,000	10
Gases and loss	5,000	5
Totals	100,000	100

Step 2. Theoretical Processing To Obtain Maximum Gasoline Yields

Products	Percent Yield from Crude	Percent Yield from Kerosene	Percent Yield Distillate
Motor gasoline	60.00	72.00	58.30
Kerosene	–	–	–
Distillate fuel and lube	–	–	–
Fuel oil	31.00	18.00	35.30
Gases and loss	9.00	10.00	6.40
Totals	100.00	100.00	100.00

Step 3. Determination of Basic Cost of Motor Gasoline Under Theoretical Processing

Cost of one barrel of crude oil, f.o.b. refinery	$3.45
Cost of processing one barrel of crude for maximum amount of gasoline, estimated	.66
Total	$4.11
Less: Fuel oil, 0.31 barrel at market value of $2.60/bbl.	.81
Gases and loss, 0.09 barrel	–
Net cost of 0.60 barrel of gasoline	$3.30
Basic cost of one barrel of gasoline ($3.30/0.60)	$5.50

Step 4. Computation of Replacement Values of Intermediate Stocks

A. Replacement value of kerosene

0.72 bbl. of potential gasoline at $5.50/bbl.	$3.96
0.18 bbl. of potential fuel oil at $2.60/bbl.	.47
Gross value per barrel	$4.43
Less: Manufacturing cost of making maximum amount of gasoline from one barrel of kerosene	.70
Replacement value of kerosene base stock	$3.73
Plus: Cost of finishing base stock to marketable kerosene	.80
Replacement value of finished kerosene per barrel	$4.53

Fig. 5. Application of replacement value method.

B. Replacement value of distillate fuel and lube	
0.583 bbl. of potential gasoline at $5.50/bbl.	$3.21
1.353 bbl. of potential fuel oil at $2.60/bbl.	.92
Gross value per barrel	$4.13
Less: Manufacturing cost of making maximum amount of gasoline from one barrel of distillate fuel and lube	.65
Replacement value of distillate fuel and lube stock	$3.48
Plus: Cost of finishing base stock to marketable distillate fuel	.45
Replacement value of finished distillate fuel and lube per barrel	$3.93

Step 5. Allocation of Actual Refinery Costs

Delivered costs of crude oil to refinery per barrel	$3.45
Processing costs to convert to actual product yields per barrel	.95
	$4.40

YIELDS

Products	Percent Crude	Replacement Value per Bbl.	Total	
Kerosene	10	$4.53	$0.45	
Distillate fuel	25	3.93	.98	
Fuel oils	10	2.60	.26	
Gases and loss	5			
	50			1.69
Motor gasoline	50			$2.71

Fig. 5. (Cont'd.)

is important to those refiners who produce specialty products requiring costly finishing operations which can be charged directly to the product benefited. Irving and Draper (Accounting Practices in the Petroleum Industry) state, "This method is used primarily in economic and analytical computations for determining the economics of various transactions."

In Fig. 5 Griffin (Journal of Accountancy, vol. 105) illustrates the determination of the basic cost of gasoline and the replacement values of intermediate stocks using the replacement value method.

By-product Accounting

BY-PRODUCT CHARACTERISTICS. By definition, by-products are products of minor importance jointly produced from common cost factors and do not have separable costs until after the split-off point. Normally they are differentiated from **co-products** (joint products) only by the degree of economic importance and the lesser amount and effort expended on them. This is not a sharp distinction but rather one of degree. As such, great care in the determination of the proper characteristic is needed.

By-products can be classed as one type of **minor product.** For example, many by-products begin as **waste materials,** become economically significant (and thus become by-products), and grow still more important, finally to become co-products. The various methods of accounting for by-products reflect this development. Generally methods showing by-product recoveries as separate income

began as offshoots of accounting for waste material when the income was so negligible as to affect neither cost nor sales. As these become more significant, the cost of the main product is reduced by **recoveries**, and finally the by-products achieve near co-product status and are allotted a share of the cost prior to split-off.

By-products can also be characterized by their relation to the **main product**:

1. By-product resulting from scrap, trimmings, etc., from main products in essentially nonjoint-product types of undertakings.
2. Scrap and other residue from essentially joint-product types of processes.
3. A minor joint-product situation.

Typical By-products. As science and technology advance and new methods of production are introduced, new products are developed, some old ones are discarded, and changes are made in the status of others. What is a by-product today may be a major product, a co-product, or scrap tomorrow. The following are typical examples of by-products:

1. Cottonseed accompanying cotton. The seed was formerly thrown away or used only as fertilizer; it is now the basis of a great oil and oil-cake industry.
2. The bagasse from the grinding of sugar cane, formerly a waste product, is now used to make wallboard.
3. The molasses left as a residuum in the making of sugar, formerly wasted for the most part, is now the raw material for industrial alcohol.
4. Methanol is now made from several former waste products, i.e., from:
   a. Gas from the manufacture of butyl alcohol and acetone;
   b. Gas from calcium carbide furnaces; and
   c. Gas produced in the fixation of nitrogen.
5. Linoleum is made in part from waste from the manufacture of cork products.
6. Paper is made in some places from what formerly was sawmill waste.
7. Fish offal is made into oil and fertilizer.
8. Small waste timber is made into rayon.
9. In the manufacture of coke, there are found such residuals as sulfate of ammonia, coal tar, benzol, and gas plus many others, all of which can be considered as by-products.
10. In the flour milling industry, the production of high-grade flour is accompanied by the production of low-grade flour, mill-feed, bran, etc.
11. In the dairy industry, the production of butter and cheese is accompanied by the production of buttermilk.
12. In the manufacture of soap, in the process of mixing and boiling ingredients, sundry rejections take place, some of which are collected for recovery as by-product, such as glycerine.
13. The top layer on the surface of the molten metal in a blast furnace is a by-product known as slag, which is successfully used in the manufacture of Portland cement.
14. Packing-house by-products are of two kinds, edible and inedible. The edible products prepared from hearts, livers, brains, ox tails, kidneys, sweetbreads, tongues, etc., are obtained in the slaughter of livestock. The inedible products are subdivided into a number of representative classes. Hides, skins, and pelts are processed into leather, wool, curled hair, and other products; fats into tallows and greases; glands into pharmaceutical products; bones, blood, and scraps into animal feed, fertilizer material, and various other products.

METHODS OF VALUING AND COSTING BY-PRODUCTS. Methods of accounting for by-products can be grouped into two major types:

1. Those methods that make no attempt to cost the by-product or its inventory, but instead make some credit either to income or to main product. When the credit is made to the major product, the method is generally known as the

by-product method. Independent by-product inventory valuation is necessary for these methods.

2. Those methods that do attempt to allocate some of the joint costs to by-products. Inventories are then carried at the allocated cost.

Noncost methods include the following:

1. Other income method.
2. Total sales less total costs.
3. Total cost less revenue from sale of by-products.
4. Total cost less value of by-products, including selling and administrative expense.
5. Total cost less value of by-products, including subsequent costs after split-off.
6. Reverse cost method.

Cost methods include the following:

1. Replacement cost method.
2. Standard cost method.
3. Joint cost proration.

NAA Research Series No. 31, Costing Joint Products, suggests that the following factors influence **by-product valuation and accounting methods**:

1. Value of by-product is uncertain at time of production.
2. Established market is available at split-off for by-products.
3. By-products are usable as substitutes for other materials.
4. By-products are alternatives to main products.
5. A separate profit and loss for by-products is needed for sales incentives or for control.

OTHER INCOME METHOD. In this cost procedure, income arising from the sale of by-products less sales returns may be recorded in one general account, or separate accounts may be opened, depending upon the variety of by-products sold and the extent to which management wishes to go in obtaining data for analysis. Net sales of by-products are closed into the current Profit and Loss account and appear in the "Other Income" or "Miscellaneous Income" section of the profit and loss statement.

This procedure for handling of by-products does not constitute a cost method, since no attempt is made to ascertain their cost. Its use is confined to those industries where:

1. The value of the by-product is unimportant or indeterminable.
2. The use of a more detailed method entails too much expense in comparison to benefits derived.
3. No clearly defined basis of separation appears and where the carrying of the by-product with the main product does not entail any appreciable difference in the cost of the main product.

The outstanding criticism of this method of accounting for by-products is in connection with **valuation of inventories** for balance sheet purposes. Normally no value is given to the by-product inventories, which results in an overstatement of major product inventory. If this method is used, the market value of the by-product inventories should be shown for purposes of information as a footnote to the balance sheet. A second criticism of this method arises in connection with the treatment of **sales of by-products.** As indicated, no entry for by-products is made at the time of production, the entry being made only at the time of sale. Unless production of by-products and its sales occur in the same accounting period, the accounting treatment is incomplete. A third criticism of this method of accounting is that no attempt is made to control the inventory of by-products, and therefore **losses due to fraud** may be an important factor. Thus under this

method all costs and expenses are charged to the **main product**. This is the least scientific method. Even where the by-product values involved are small, their inclusion as nonoperating income tends to distort the entire picture of operating results.

TOTAL SALES LESS TOTAL COSTS. This is a variation of the "Other Income" method. Costs of all products are subtracted from sales of all products. Thus no cost allocation is made at all. It is obviously open to all the criticisms of the first method.

TOTAL COST LESS REVENUE FROM SALE OF BY-PRODUCTS. The first two methods discussed before may be varied by treating the proceeds from the sale of by-products as a deduction from the cost of the main product. This method is practically identical with some of the procedures in accounting for waste, scrap, and spoilage. Illustration:

Sales of main product (1,000 units at $10)			$10,000
Cost of sales:			
Produced (1,200 units at $8)	$9,600		
Less by-product sales (1,000 units at $.60)	600		
Net cost of major product		$9,000	
Less inventory major product (200 units at cost, 1/6 of net cost)		1,500	7,500
Gross profit			$ 2,500
Selling and administrative expense			500
Net profit			$ 2,000

The deduction of by-product sales from total production cost yields a different main product cost, and hence provides a base on which to calculate the inventory

Monthly Profit and Loss Statement

Sales: Coke (204,000 at $25.00)			$5,100,000
Cost of Sales:			
Beginning inventory (80,000 at $21.50)		$1,720,000	
Produced (201,000 at $26.26)	$5,277,846		
Less by-product sales:			
Benzol (270,000 at $.35)	94,500		
Toluol (55,000 at $.35)	19,250		
Xylol (45,000 at $.35)	15,750		
Pure still residue (35,000 at $.09)	3,150		
Crude solvent (24,000 at $.20)	4,800		
Crude naphthalene (123 at $50)	6,150		
Gas (1,170,000 at $.22)	257,400		
Tar (1,650,000 at $.13)	214,500		
Sulfate (3,000 at $44)	132,000		
Pyridine (2,000 at $1.10)	2,200		
Total by-product sales	749,700		
Net cost (201,000 at $22.24)		4,528,146	
Available cost (281,000 at $22.24)		6,248,146	
Less inventory (77,000 at $19.47)		1,499,190	
Cost of sales			4,748,956
Income before taxes			$ 351,044

Fig. 6. Revenue from sale of by-products deducted from total costs.

value of the major product which is different from that used in the first two methods. The basic assumption is that by-product revenue reduces the cost of the major product, and because of the close analogy to waste and scrap accounting, it is favored by some accountants.

In Fig. 6, Self (NAA Bulletin, vol. 38) illustrates this method for coke and coke by-products production and sale. Self notes that:

This method has a tendency to understate the cost of coke. Also, it creates an unstable cost from month to month because of the varying quantities of by-products sold. The understatement of coke cost could cause the sales department to establish a sales price below actual cost and, if a steel producing plant is involved, all products manufactured in subsequent processes would be understated.

TOTAL COST LESS VALUE OF BY-PRODUCTS (Including Selling and Administrative Expense). Here there is still no separation of production costs either before or after point of "split-off." But proceeds from sale of by-products are charged with selling and administrative expense connected with the handling of the by-product; the net yield obtained is credited to the cost of the main product. This method is fairly common. Illustration:

Sales of main product (1,000 units at $10)			$10,000
Cost of sales:			
Produced (1,200 units at $8)		$9,600	
Less by-product value:			
Sales of by-product (1,000 units at $.60)	$600		
Selling and administrative expense (assumed)	80	520	
Net cost of main product		$9,080	
Inventory main product (1/6 of net cost)		1,513	7,567
Gross profit			$ 2,433
Selling and administrative expense		$ 500	
Less amount allotted to by-product		80	420
Net income			$ 2,013

TOTAL COST LESS VALUE OF BY-PRODUCTS (Including Subsequent Costs and Distribution Expense). This method is an improvement over the prior methods in that it charges the by-product for selling and administrative expense and also for production costs subsequent to the split-off point.

In Fig. 7 it is assumed that the **joint cost** is $8,500 and the subsequent costs are $500 for the main product and $600 for the by-product. These figures make up the total **production cost,** which is therefore the same as in previous illustrations. Since the joint cost is charged entirely to the main product, the by-product inventory, when valued at cost, carries only subsequent costs. Thus the unit by-product inventory value is $600 divided by 2,500 units, or $.24. This is the figure used in valuing the inventory of the by-product in the illustration.

Selling and administrative expenses are charged only against by-products actually sold. If distribution costs are to be charged against the inventory of by-products, further complications arise. Note that the by-product inventory in the illustration has been taken up on the books.

The **beef-packing industry** furnishes an outstanding example of using the net yield on by-products to reduce the cost of the main product. Special interest attaches to by-product accounting in this industry because of the great variety of products resulting from operations and the complexity of the processing.

According to Child (Journal of Accountancy, vol. 82), "The costing of beef is the costing of one major product, namely, dressed beef, and such by-products as tallow, hides, casings, and bones."

Sales main product (1,000 units at $10)				$10,000
Cost of sales:				
Joint cost (charged to main product) (1,200 units)			$8,500	
Subsequent costs main product (1,200 units)			500	
Total charges to main product			$9,000	
Less net yield from by-product:				
By-product sales (1,000 units at $.60)	$600			
By-product inventories (1,500 units at cost, $.24)	360			
Total by-product values		$960		
Less subsequent cost to produce (2,500 units)	$600			
Selling and administrative expense	80			
Total costs and expenses		$680		
Net yield of by-product			280	
Net production cost of main product (1,200 units)			$8,720	
Less inventory main product (200 units at cost)			1,453	
Cost of sales main product				7,267
Gross profit				$ 2,733
Selling and administrative expenses			$ 500	
Less amount allocated to by-product			80	420
Net income				$ 2,313

Fig. 7. By-product yields deducted from joint costs.

The **beef cost test** is used to arrive at the cost per hundredweight of dressed beef for each lot. Fig. 8, adapted from a detailed illustration by Greer and Smith (Accounting for a Meat Packing Business) illustrates this test.

The raw material purchased is the live animal; the major product is dressed beef; by-products consist of hides, edible fats, and a variety of other edible and inedible items. Under the usual cost accounting practice followed by the industry, the cost sheet on a test lot shows:

1. Total amount paid for live cattle.
2. An allowance for expenses normally incurred in the slaughtering and dressing process and in chilling and temporary storage of dressed beef. Expense figures used are based on previous average experience, possibly with some adjustment for any differences in current wage rates, volume of production, or other factors

Some by-product credits are arrived at from actual weight or measurement of by-products produced from this particular lot, while other figures are estimated on the basis of **normal experience.** For example, the so-called green weight of hides may be determined by actual weighing as the hides leave the killing floor, but the cured weight which is finally available for sale must be estimated on the basis of the past experience. Similarly some fats can be weighed at time of the slaughtering operation, while others are recovered at such other times and places that it may not be practical to take their actual weights, an estimate being necessary. The amount of yield of edible and inedible oils also must be estimated, and

BEEF COST TEST

Kind of cattle: Steers Bought from: J. Williams Date: July 7, 19__

Cost and Value Summary

	Percent	Totals for Test Lot	Per Cwt. Live Wt.	Per Cwt. Dressed
1. Cost of live cattle at plant........		$2,415.23	$24.04	
2. Less: Value of by-products		263.30	2.62	
3. Net cost of cattle, by-products deducted		2,151.93	21.42	
4. Percent dressed yield	57.7%			
5. Net cost of cattle, by-products deducted				$37.12
	Per head			
6–9. Total manufacturing expense.....	$10 73	107.30	1.07	1.86
10. Total cost of carcass at plant door..		$2,259.23	$22.49	$38.98
11. Transportation (incl. shrinkage)...				1.06
12. Local selling and delivery expense..				1.06
13. Total, sold-delivered cost..........				$41.10
14. Selling price, estimated				41.26
15. Profit, estimated				+$ .16

Weight and Yield Data

	No. of Hd.	Total Weight (lb.)	Av. Wt. per Hd. (lb.)	Percent Yield
21. Live cattle slaughtered	10	10,080	1,008	100.0
22 Hot dressed weight of carcasses passed (after deducting condemned)	10	5,974	597	59.2
23. Allowance for cooler shrink (2½%)		149	15	1.5
24. Chilled dressed weight of carcasses at plant door		5,825	582	57.7

Fig. 8. Beef cost test.

of course expenses to be incurred are entirely matters of estimate. When the calculation has been completed, the **net value of all by-product items** is combined into one total and deducted from the aggregate expenditure previously recorded. The resultant net cost is allocated to the **major product**, dressed beef. A further calculation is necessary to convert cost per hundredweight alive into a cost per hundredweight dressed, due allowance being made for the initial yield of dressed beef and for subsequent losses which may take place due to shrinkage, trimming in coolers, etc. This cost ultimately is measured against the selling value of dressed beef, to determine the profit or loss on the operation.

Under the foregoing procedure, profit or loss should appear only in the account for sales of dressed beef, since by-products have been set up on the books at a theoretical net recoverable value. As a matter of fact, the procedure does not lead to the elimination of all profit or loss on by-products, since many computations are estimates and actual experience often is somewhat different. For example, the net amount of each by-product recovered may be somewhat more or less than was estimated; the price at which it is finally sold may be above or below the price used in the cost calculation, and the expense of processing may be greater or less than was anticipated. Thus the by-product accounts typically do contribute some additional profit or loss to the amount figured on the major product.

REVERSE COST METHOD. The so-called method of working backwards, also called the "reverse cost" method, is in effect equivalent to the method described before by which the net yield from the by-product is deducted from total costs. But it may be used also to determine the amount of cost it is economically possible to allocate to the main product. This is done by deflating the selling price of the by-product by an assumed gross profit margin (to cover estimated net profit and selling and administrative expenses) and by the production costs subsequent to the split-off point. The net amount deducted from the joint costs represents the main product's share of the joint cost. In Fig. 7 the by-product yields are assembled and deducted from the joint costs. The result is the share of joint cost allotted to the main product. In this way a unit cost for the main product may be obtained by dividing the calculated cost by the yield. The net profit obtained is, of course, exclusive of the profit on the by-product.

This method is illustrated in connection with the calculation of **allowable purchase prices** under Standard Costs and Joint-Cost Analysis in this section.

REPLACEMENT COST METHOD. In this method the cost of by-products utilized within the plant are valued at the **opportunity cost** of purchasing or replacing the products in question. NAA Research Series No. 31, Costing Joint Products, gives as examples the unsalable by-products used as fuel and the scrap used in further operations of steel mills. Wasley (NAA Bulletin, vol. 34) cites the following example of the use of a by-product as **boiler fuel**:

> Coke breeze represents the minus 1-inch coke, screened from the coke production. It is used as boiler fuel in plants equipped with stokers, and is also sold in the open market. The assigned value of coke breeze for boiler fuel is calculated as a replacement of natural gas according to B.T.U. content, the formula being as follows: Cost of Natural Gas ÷ B.T.U. per M.C.F. × B.T.U. per ton of coke breeze.

The assigned value of coke breeze held for sale is valued at the selling price less agreed selling margin less shipping expense.

Successive Processes. The manufacture of **steel** involves a number of successive processes in each of which there is a major product and one or more by-products. The distinguishing feature with respect to by-products is the recovery of a number of substances which are not sold as such but are used wholly or partly in other manufacturing processes. The major line of processing proceeds through the manufacture of coke, production of pig iron in blast furnaces, and production of steel ingots in open hearth furnaces, to rolling of ingots into rails, bars, sheets, and structural shapes.

Some of the most important by-products are recovered in the manufacture of coke, and the typical large steel plant has extensive processing departments devoted to the recovery and further processing of these by-products (sulfate of

ammonia, benzol, phenol, tar, etc.). Many of these by-products are sold. On the other hand, blast furnace gas, coke oven gas, and some tar derivatives may be mixed and used for heating in open hearth furnaces; waste heat from open hearths is used in the generation of steam, which is converted into power for use by various operating departments; scrap metal recovered in various processes is remelted to produce new steel ingots, etc.

The following methods of by-product accounting are used by one large steel company:

1. Coke oven by-products credited to cost of coke at the average sales price per unit for the month.
2. Coke oven and blast furnace gas credited respectively to cost of coke and cost of pig iron at computed value based on cost of fuel oil yielding equivalent heat units.
3. Tar and pitch used as fuel credited to cost of coke at computed value based on cost of fuel oil yielding equivalent heat units.
4. Remelted scrap steel credited to cost of finished steel at market cost of equivalent grades purchased.
5. Waste heat from furnaces used to generate steam, credited to steel ingot cost at computed value based on cost of coal yielding equivalent heat units.

Note that in some instances the values are those recoverable on the sale of products, while in others they are the equivalent costs of similar products if purchased independently for use in manufacturing processes.

Substitute Products. In certain cases an increase in by-product increment is related to a decrease in the main product. When this is the case, the by-product in effect is a substitute or **alternative product.** According to NAA Research Series No. 31, by-products produced under such conditions are usually assigned the value of the main product foregone through production of the by-products (see discussion in this section under Replacement Value Method).

Keller (Management Accounting for Profit Control) states that it may be unsatisfactory to base the value on a unit-for-unit replacement of the other raw material. He says:

> . . the value of the by-product as a substitute material is the difference between total factory cost of production using the specified raw material and the total factory cost of production using the by-product at no value. From this difference would be deducted the costs of getting the by-product from the producer to the user of it as a substitute The net amount would be the maximum credit to the producing prime product. Company policy may call for this to be split between the producer and the user, so as to provide an incentive to the user to make the substitution.

TOTAL COSTS LESS BY-PRODUCTS VALUED AT STANDARD. Under most of the methods discussed above, the **yield** or **net yield** from by-products is the value assigned to them. These yields are normally expressed in terms of proceeds from sale, i.e., current market value. If fluctuations in the value of by-products occur, it is difficult to determine whether the resulting **cost fluctuations** are due to variances in the costs of the main product or of the by-product. Thus Blocker and Weltmer (Cost Accounting) are led to recognize the criticism that **supply and demand factors** determine price of by-products and that they are quite apart from those applicable to either raw material or the major commodity. They state, "In cases where selling prices fluctuate widely, this is a just criticism."

Because of these difficulties, the suggestion sometimes is made to credit Work in Process for by-product values at a **standard** price. The standard may be an

arbitrary figure, or it may represent the average price over a period of time, but it presumably represents an effort to stabilize the market value of by-products.

According to Henrici (Standard Costs for Manufacturing), no particular complications arise in the operation of the standard cost system with the inclusion of **by-product standards** except that a further variance account is introduced to cover the difference between actual and standard quantities of by-product relative to the quantity of main product. (Standard costs for joint products are discussed under Standard Costs and Joint-Cost Analysis in this section.)

JOINT-COST PRORATION METHOD. Another method of by-product accounting is to charge each product for costs subsequent to the split-off point and to apportion the joint costs between the major products and by-products on some acceptable basis (see Joint-Product Accounting in this section for applicable methods). If joint-cost allocations are to be made, theoretically this general method is superior. However, the cost of such determinations may logically preclude its use. It is true, however, that in the absence of proration, the resulting costs may be misleading. A lack of detailed cost data makes itself felt in improper inventory values, erroneous sales policies through improper pricing of the product, etc.

BY-PRODUCT COSTING AND MANAGERIAL POLICY. Accounting treatment of by-product credits frequently must recognize the effect which valuation policies and practices may have on internal managerial decisions. Thus, while inventory figures for balance sheet purposes may ordinarily be the prime consideration, other requisites do influence the accounting treatment. NAA Research Series No. 31, Costing Joint Products, outlines the following as pertinent **decision areas:**

1. Effect of by-product valuation on utilization of materials, both within the company and by outside customers.
2. Need for separate profit and loss statements for by-products and the effect on by-product valuation.
3. Need for separate profit accountability in by-products in order to provide value incentives

Values placed on by-products may affect the use of materials within the company. In a **decentralized** company many officials have the capacity to make decisions on both the kind and quantities of materials used. When this is the case, each divisional manager tends to make decisions in the light of costs assigned and of the resulting profits shown in his own operation. (This general subject is covered in detail in the section on Special Cost Analyses.) Keller (Management Accounting for Profit Control) lists as a **principle of valuation**: "The value should provide for economic costing and consequent competitive pricing of the product which produces the by-product as well as of the commodity which uses it." NAA Research Series No. 31 adds, "The competitive advantage of the company accruing from its development of a complete line of products using all grades of raw material and by-product material shall not be impaired within commodity groups by establishing values in excess of market prices available to competitors producing like products."

Separate **by-product profit and loss** is frequently computed in order to determine ability of by-product to absorb costs after the split-off point. In these instances by-products are usually assigned no value at the split-off point, the major products absorbing all joint costs. Sometimes this is done to measure utilization of previous waste, and sometimes it is done to keep major product costs from fluctuating.

Frequently the separate profit and loss calculations are made in order to provide incentives to sell the by-products. In order to achieve this, a desired profit is predetermined by management and included with the manufacturing and marketing costs deducted from the selling price of by-products. This becomes the inventoriable cost of by-product and the credit to major products. In these instances the amount of profit varies with quantities sold, but the **gross profit rate** is determined by managerial decision.

BY-PRODUCT INVENTORY VALUATION. Where by-products are recorded only as sold, inventories appear as memoranda. Where market values form the basis of entries at the time of sale, the by-products on hand at closing time may be valued at current market price, with or without deduction for estimated distribution costs. This implies that the inventory is valued at market irrespective of cost; if costs are below market value, anticipation of profit occurs. This is particularly true of by-products which have no costs charged against them.

Standard Costs and Joint-Cost Analysis

STANDARD ALLOWABLE COSTS. Under this cost procedure raw material costs are apportioned to products on the basis of **predetermined standards.** In joint-product industries the sales price is fixed in commodity markets and controlled by supply and demand; the problems of management center on purchasing and conversion rather than on conversion and selling. Therefore the cost procedure adopted, to be of a maximum value, must provide management with the following information:

1. A convenient method for determining the price which can be paid for any given lot of raw material.
2. Means of measuring actual yields against those anticipated at the time of purchase of the raw material.
3. A comparison of actual conversion costs with those anticipated and used in establishing purchase prices.

According to Keller (Management Accounting for Profit Control), these requirements have been met successfully by the operation of a standard cost system in a company whose activities are confined to the purchase, preparation, and sale of a natural product. A year's supply of raw material is purchased, either at public auctions or privately, from many growers spread over a large geographical area. Thus material purchased in any one year varies as to quality, depending upon climatic conditions of the localities from which it is secured. The price paid for each lot is based upon the expected yield of grades as established by test sorting of representative portions before purchase. Material standards are used as a basis for calculating allowable purchase prices. For the purpose of illustration, it is assumed that the following rates have been established:

Purchase expense	$ .50 per cwt.
Conversion cost:	
Labor	2.50
Factory burden	1.00
Total	$4.00
Administrative and distribution cost	20% of sales
Desired profit	10% of sales

With this information, the forecast sales prices by grade, and an established allowance for scrap, the accountant is in a position to furnish the purchasing agent with a **schedule of prices** which can be paid for the various grades of raw material. Keller (Management Accounting for Profit Control) calculates this as shown in the accompanying tabulation:

SCHEDULE OF ALLOWABLE PURCHASE PRICES OF GRADES

	(1)	(2)	(3)	(4)	(5)	(6)
Forecast sales price	$200.00	$100.00	$50.00	$30.00	$20.00	$10.00
Less provision for profit and selling and administrative expenses (10% + 20% = 30%)	60.00	30.00	15 00	9.00	6.00	3.00
Balance	$140.00	$ 70 00	$35.00	$21.00	$14 00	$ 7.00
Available factory cost (90% of line above, allowing for 10% loss)	126.00	63.00	31.50	18.90	12.60	6 30
Conversion cost and purchase expense	4 00	4.00	4 00	4 00	4.00	4.00
Price f.o.b. factory which can be paid for raw material ...	$122 00	$ 59.00	$27.50	$14.90	$ 8.60	$ 2.30

Standard Material Price. The last line in the preceding table shows the maximum price that could be paid for a lot if it tested 100 percent grade 1 or 100 percent grade 2, etc. Assuming a given lot tests as shown in the following table from Keller, the maximum price is $15.84, which becomes standard for the lot.

ALLOWABLE PURCHASE PRICE FOR A SPECIFIC LOT

Grade	Percent	Allowable Grade Price	Factor
1	2	$122 00	$ 2.44
2	6	59 00	3.54
3	12	27.50	3.30
4	25	14.90	3.72
5	25	8.60	2.15
6	30	2.30	.69
	100		
Maximum price per cwt. f.o.b. factory			$15.84

The cost accountant receives a report of each lot purchased. Quantities on the report are priced at the standard price per hundredweight. A summary is then prepared on the standard values of all lots, and the total is adjusted for expected scrap loss. Total standard value is then allocated to grades as shown in the table on the following page, adapted from Keller.

Since the total actual material cost is 55 percent of the forecasted sales price, the **joint material cost** is distributed to the various grades by taking 55 percent of the expected sales price for each grade. Conversion costs (labor and overhead)

CALCULATION OF MATERIAL COST BY GRADES

Grade	Expected Yield in Pounds	Forecast Sales Price per Cwt.	Forecast Sales Values	Total Material Cost	Material Cost per Cwt.
1	100,000	$200.00	$200,000.00	$110,000.00	$110.00
2	200,000	100.00	200,000.00	110,000.00	55.00
3	400,000	50.00	200,000.00	110,000.00	27.50
4	500,000	30.00	150,000.00	82,500.00	16.50
5	500,000	20.00	100,000.00	55,000.00	11.00
6	800,000	10.00	80,000.00	44,000.00	5.50
Totals	2,500,000	$ 37.20(a)	$930,000.00	$511,500.00(b)	$ 20.46

(a) $930,000 ÷ 25,000 = $37.20.
(b) $511,500 ÷ $930,000 = 55 percent.

are calculated at a uniform figure per hundredweight for all grades. As sorting and processing proceeds, the variances from standard material cost are segregated as to cause: purchase price, yield, and scrap. The procedure follows that of the **process standard cost system** (see section on Operation of Standard Costs).

BASIC STANDARDS FOR JOINT PRODUCTS. Camman (Basic Standard Costs) draws a distinction between **graded products** and **joint products**, on the ground that precise standards of yield may be established in the case of joint products, but that no such precision exists in the case of graded products. The distribution of the joint cost is made on the basis of the market value of the products to be recovered and the subsequent processing costs. In setting the standards, two more factors, however, must be considered:

1. Yield variations.
2. Content of the products in the original material.

Thus a distinction is made between the two types of **yield variances**, those due to changes in the content of the original material and those resulting from gains or losses in processing. The latter are, of course, usage or effectiveness variances. Thus, in order to obtain proper yield variances, it is necessary by testing, sampling, chemical analysis, or by any other means to ascertain the composition of the raw material.

By incorporating the composition of the raw material in the basic standard, variances which might arise from the composition of the material are automatically eliminated, and any yield variance shown must therefore result from processing activities. Thus the **basic standard** includes:

1. The formula in which the products should be recovered.
2. Market differential.
3. Subsequent recovery costs.

BASIC STANDARDS FOR GRADED PRODUCTS. Many industrial processes using a raw material in bulk produce finished products of varying grades or quality and consequent variances in selling prices. Thus, for example, in fruit canning, raw fruit is purchased in bulk but processed in a variety of ways and sold on the basis of established standards of quality, yielding different prices. Peaches

are packed in halves, sliced, whole, and diced, and each of these is packed in several sizes of containers, and again each in several grades. Similarly, leaf tobacco is purchased in bulk, graded for quality, the joint cost being apportioned over the entire lot in proportion to the respective selling values of the various grades. The same is true in the fur industry where skins are bought in bulk and then graded for quality.

Apportioning Joint Costs. Distribution of the joint cost of bulk material to be graded is made on the basis of the **actual yield** of the different grades obtained and their respective market values. The handling and processing costs up to the stage where the grades are determined, as well as the original cost of the purchase, are included in the entire cost to be distributed. Basic standard costs are used to accomplish this. **Grade market differentials** are introduced in setting the standards. In this way the actual costs are distributed on the basis of the standard costs of the products recovered, where the standards reflect the market values

Since the basic standard costs are fixed, the initial costs are apportioned by a set differential. Then, if the actual market values of the products change disproportionately, the effects are disclosed in the resulting profits and are not hidden in costs distributed on the basis of the changed market values.

Yield Variance. A yield variance arises because actual recovery of the end products is different from the standard expectation. Both the actual recovery and expected yields can be reduced to ratios or percentages.

The aim of the manufacturer is, of course, to obtain as high a yield as possible, particularly in the more valuable grades. Even with uniform margins of profit on all grades, an increase in the yield ratio of the better grades results in a larger amount of profit.

APPLICATION OF BASIC STANDARDS TO GRADED PRODUCTS. The usefulness of basic standard costs in the solution of joint-cost problems is illustrated in the case of canneries. The chief accounting problem of canneries is the apportionment of the joint costs of raw material, labor, and overhead. The **raw product** is purchased at a flat price per ton. This is a joint cost yielding different **grades** of finished pack. The selling prices on the lower grades normally do not equal the average price per pound of the fruit used. Therefore the raw product cost cannot be charged to the various grades at a uniform price, but the higher grades must be charged enough above the average price per pound to make up for the lower grades.

Grade Differentials and Cost Elements. To obtain variable fruit costs, more or less arbitrary grade differentials are established whose effect is to weight raw material costs in such a way that the more expensive grades absorb a greater proportion of the joint cost. In effect this is a form of proration based on market values.

Setting Raw Product Standards. Raw material costs are prepared on a standard cost basis in advance of the season. They take into account the quantity required, the price to be paid, and grade differentials.

Fig. 9 shows a hypothetical example of such a calculation. The percentages in column 2 are based on averages of several prior seasons. Column 3 figures represent grade differentials. Multiplying the figures in column 2 by those in column 3 in effect translates the expected yields into **equated yields** on the basis of the standard grade. That is, 100 pounds of fruit assorted as shown in Fig. 9 are equal in value to 100.25 standard pounds of fruit.

(1) Grades	(2) Expected Yield of Grades in Percent	(3) Relative Grade Price	(4) Product (2) × (3)	(5) Standard Grade Price per Pound
Fancy	10	130	.1300	$.04026
Choice	40	115	.4600	.03562
Standard	20	100	.2000	.03097
Second	15	75	.1125	.02323
Water	10	75	.0750	.02323
Pie	5	50	.0250	.01549
Totals	100		1.0025	

Fig. 9. Calculation of raw product standards.

By comparing the standard equivalent with the expected price for fruit, an average cost per standard pound of fruit is obtained.

A total cost of $62.10 represents the expected cost of an assortment of 2,000 pounds, which according to Fig. 9 is equal to 2,005 standard pounds (i.e., 2,000 × 1.0025). Thus the cost per standard pound of fruit is $62.10 ÷ 2,005 = $.03097.

To find the **standard grade price** per pound for each grade, multiply the above unit cost by the grade differentials. The results are shown in column 5 of Fig. 9. Finally the standard raw product cost per case is obtained by grades and sizes by multiplying the standard grade price per pound by the number of pounds per

Cost and Variance Reports. Total standard costs are calculated for each day's pack. In the same way labor costs by grades, sizes, and processes are computed. The unit costs are in all cases obtained from tables showing the standard fruit cost per case and the direct manufacturing charges. Comparisons are made daily of actual with standard costs. The variance in raw product costs may be due to all or any one of three factors:

1. Use of more or less pounds of fruit per case than standard; i.e., usage variance, often called the fruit yield.
2. Variance in price per pound; i.e., **price** variance.
3. Higher or lower yield per case; i.e., a **yield** variance; this is commonly referred to as the grade yield.

In each case the actual quantity or cost is divided by the standard quantity or cost to yield a ratio which forms the basis for the variance calculations. The **yield variance** is important since fancy grades of fruit may be worth several times as much as low grades. Packing fancy grade fruit into low-grade product affects the profits as seriously as using a greater volume of the fruit than necessary. Correction cannot be made for a high cost of raw product per case without knowing whether the high cost results from using too much raw product in packing or failing to obtain high enough grades.

Variations in Technique. The foregoing technique of cost application for canneries is sometimes criticized on two grounds:

1. The base against which variances are computed.
2. The kind of variances obtained.

According to this line of reasoning, the variances are computed against a hypothetical base. A distinction must be drawn between variances in the material costs of **graded products** and those which may be encountered in the production of **joint products.**

Joint-Cost Analysis and Managerial Decisions

JOINT PRODUCTION AND DECISION MAKING. Accounting treatment of joint costs has dealt largely with the historical procedures needed for periodic financial reporting. As in many other areas in cost accounting, special studies and statistical analyses are frequently needed in this area for short and long term planning. In making decisions relative to jointly produced articles, it should be remembered that the products are necessarily produced jointly. According to the Committee on Price Determination of the National Bureau of Economic Research (Cost Behavior and Price Policy), a general purpose allocation of costs among products is barren, and the allocation of costs to products must be directed toward specific problems. Similarly, NAA Research Series No. 31, Costing Joint Products, quotes Vatter as stating that the real problem of cost accounting from this viewpoint is not so much working out the bases of distribution but of establishing when and how much cost is relevant to a given decision.

The above NAA research study lists the following areas as being central to **joint-product decisions:**

1. How to determine the effect which increases or decreases in output of jointly produced products have on costs and profits.
2. How to ascertain the most profitable mix of jointly produced products.
3. How to determine whether it is more profitable to sell a joint product or to process it further.
4. What cost data to use as a guide in pricing jointly produced products.
5. What cost and profit data are helpful in internal control of operations where costs are joint.

EFFECT OF FEDERAL INCOME TAX LAWS. Some accountants have tried to lean on the Federal income tax laws and regulations for solutions to the joint-cost problem. The most pertinent statement is Regulation §1.471–7, which states:

> A taxpayer engaged in mining or manufacturing who by a single process or uniform series of processes derives a product of two or more kinds, sizes, or grades, the unit cost of which is substantially alike, and who in conformity to a recognized trade practice allocates an amount of cost to each kind, size, or grade of product, which in the aggregate will absorb the total cost of production, may, with the consent of the Commissioner, use such allocated cost as a basis for pricing inventories, provided such allocation bears a reasonable relation to the respective selling values of the different kinds, sizes, or grades of product.

Although it appears to authorize the use of the market value method, the **average unit cost method** has been allowed (see discussion in this section under Average Unit Cost Method) in certain cases. Moreover, as Matz–Curry–Frank (Cost Accounting) point out, the regulations do not unequivocally authorize the **market value theory.** They point out that the regulations stress the use of a method "in conformity to a recognized trade practice" which may "with the consent of the Commissioner" be used. Thus the Commissioner must study the specific problem. Again this becomes a matter of reasonable **cost policy.** Matz–Curry-Frank further state that the Commissioner thus virtually becomes the

enactor of the law, since the courts to which recourse may be had also work under the same vague general statement. The tax authorities are thus no better off than the producer. If the industry does develop a better method, it seems reasonable either that the regulations should allow it or that they should be changed to permit acceptance of the method.

OUTPUT DECISIONS. The usefulness of joint-cost allocations for output decisions is dependent on the flexibility of the joint production.

Technologically Fixed Joint Production. In the case of technologically fixed joint production, joint products, whether co-products or by-products, emerge in the same proportion. Variations in yields are due only to efficiency in the separable production. It is generally agreed that if the proportion of joint products is fixed, cost allocation is impossible as well as useless, since there is no alternative but to produce the package. Instead, the total cost of the joint products has to be compared with the combined sales revenues for measuring **profitability** at any given output. Thus NAA Research Series No. 31, Costing Joint Products, states, "For this reason some companies make no attempt to determine profit or loss on individual co-products. Other companies have separate profit and loss figures, but do not use them in making output decisions." Where the joint products consist of a main product and by-products, the combined profit and loss figures are generally used. However, in some instances by-products are disregarded in making output decisions for the main product.

It is noted that technologically fixed joint production has a time dimension, and what is fixed in the short run may well vary in the long run. However, the cost of varying the **product mix** may be so high in many cases as to make it unpractical to change the mix.

Fixed Proportions Due to Demand. The above NAA research study also recognizes as a case of fixed proportions the situation where the product mix is determined by demand. Thus the NAA study states, "In oil refining some variation in the product mix is possible, but products must be produced in proportions desired by customers." This is not a true case of fixed proportions (although the producer may lose freedom to vary proportions), and the oil refining industry has recognized it by using the gasoline replacement method to some extent. In other situations **joint demand** may be so invariable that it may be more convenient to consider it as demand for a single product.

Products Jointly Produced in Variable Proportions. Frequently common costs are incurred for products that are either alternative to each other or are unassociated with each other. Thus, increasing the output of one will either cause a reduction in the output of the other or have no effect on the output of the other. The latter case warrants the use of **incremental** cost analysis (see section on Cost-Volume-Profit Relationships for further discussion); in the former case, **opportunity cost** concepts can be used as in the replacement method in oil refining.

When the proportions in which the joint products emerge can be controlled, the range of control is usually greater over a long period than over a short period. Thus NAA Research Series No. 31, Costing Joint Products, states, "In the short run, existing manufacturing equipment limits alterations in product mix and existing customers determine what can be sold. With additional time, a new manufacturing process can be developed, new manufacturing equipment can be acquired, and new markets can be found." The oil refining industry again is given as an example.

In comparing alternative **product mix** situations when costs of individual joint products cannot be measured with certainty, it is better to measure the total **cost differentials** and compare them with the total **sales differentials** for each alternative. In this way the differentials between alternative product mixes can be determined. Two procedures are usually followed:

1. An over-all budget is prepared for each alternative.
2. Differential computations alone are used.

Where the number of variables used in evaluating alternatives is large, computations are expensive and time consuming. In that case, either approximations are made or more precise determinations are obtained through use of electronic computers.

Output decisions for **new products** similarly have to take into account alternative production, not only of rival products but also of desirable or undesirable by-products.

Arentson (NAA Bulletin, vol. 28) also notes that for output decisions, the product-mix costing sometimes has to be abandoned. Thus Arentson states,

> It must be remembered that the split made between high and low pressure steam is for distribution and control only. It has little value when making policy decisions as to the purchase or installation of new equipment. For this cost determination an over-all balance must be used to arrive at the correct answer. It is conceivable that in a plant with an excess of exhaust steam, the exhaust steam should, for the purposes of the immediate problem, be considered to have no cost.

Cut-off Production Points. Frequently decisions have to be made whether to dispose of a by-product or co-product at a given stage or to continue to process it further. Only **cost incurred,** or to be incurred after the split-off point, and the **sales value** of the individual product are pertinent in this decision. The decision rests again on the differentials between these. Costs incurred prior to the separation point are incurred regardless of the decision to be made as to subsequent processing. For this reason they are not relevant to the decision. When one alternative in the comparison is to use the joint product in question as a material in further operations, the sales value is replaced by the **cost of replacement** with material from another source. Basically this entire problem is not a joint-cost problem, since the alternatives involve separable costs after the split-off point. The solution is thus the general one of individual product output.

PRICING JOINT PRODUCT. NAA Research Series No. 31, Costing Joint Products, shows that companies in industries characterized by joint production with an inflexible output mix have often stated that costs computed for individual products have little influence on pricing decisions. Thus, "It is necessary to dispose of the output of all products, and prices of individual products are accordingly adjusted to sell the products in the proportions to which they are produced." This, of course, is a variation of **product-line pricing** (see section on Special Cost Analyses, for a general discussion of pricing).

Further, the NAA research study states, "The only reliable measure of profitability for an individual joint product is the contribution it makes to joint costs after separable costs assignable to the product are deducted from its sales value."

While the sales or market price method of joint-cost allocation to joint products maintains a constant relationship of cost to market prices of product, it cannot be used to set prices, since the selling price has to be known in order to determine cost. Even if the method is circular, it has been found useful in limited situa-

tions. For example, Child (Journal of Accountancy, vol. 82) states, "The industry is not particularly interested in the individual costs of these by-products but only in their market value, since market value determines to an important extent the price at which the main cuts can be sold to make a profit." Also, as has been discussed in this section, such allocations are useful in determining prices to be paid for raw materials.

Sometimes **historical market differentials** between products have been used to allocate common costs. If these market differentials are fairly stable over the years, the practice can supply a guide to pricing individual products and give figures that are comparable to those of competitors.

The sales value method has also been found worthwhile in attempts to justify prices and existing price relationships to regulatory bodies and others.

If joint products are of variable proportions, meaningful decisions can be made for each individual product by comparing differential cost with differential sales revenue. However, in general, as NAA Research Series No. 31, Costing Joint Products, states, "While costs determined for individual products may be useful guides to pricing in some situations, it seems essential that in making pricing decisions, management should always consider the whole picture presented by a group of joint products."

INTERNAL CONTROL. Individual product costs of joint products calculated and included in cost accounting systems are useful for purposes of internal cost control. These controls may take the form of **norms** to be used as measures (and incentives) by middle management, for intra-company pricing, to delineate managerial responsibility, etc. Care must be taken, however, in the use of allocated joint costs, since the allocations may introduce fluctuations not related to managerial performance and may focus attention on the method of allocation rather than on the amount of cost to be controlled.

In industries characterized by joint output of multiple products, the principal guides to processing efficiency may well be physical yields of individual product. Again, a composite weighted average index, called the **index of production**, may be used in lieu of allocated joint costs for comparative purposes. While this does not provide cost control, it affords a measure of output efficiency and a useful guide to purchase of raw material.

SECTION 14

ESTIMATED COSTS

CONTENTS

CONTENTS (*Continued*)

SECTION 14

ESTIMATED COSTS

Basic Concepts

NATURE AND DEFINITION OF ESTIMATED COSTS. Modern business frequently requires an understanding of the nature and magnitude of costs before production starts, and in some cases even before a sales order is accepted or a contract is entered into for the providing of a particular good or service. A cost may need to be known for the purpose of quoting selling prices or for the purpose of providing the necessary financial resources for carrying on a particular activity. In other cases the behavior of a cost in terms of probable increases or decreases as the volume of production changes may need to be known. It is the purpose of estimated costs to indicate these qualities of cost behavior even before operations begin. An estimated cost, therefore, is one which gives a predetermined expression of the magnitude and behavior of a cost for application in determining business policy.

Kohler (A Dictionary for Accountants) defines estimated costs a little differently: "The expected cost of manufacture or acquisition, often in terms of a unit of product, computed on the basis of information available in advance of actual production or purchase." Similarly, F. S. Howell (NAA Bulletin, vol. 32) defines **cost estimating** as "the process of computing the anticipated cost of items not yet produced in those cases in which past experience cannot furnish the historical cost of identical items produced under similar circumstances."

Sometimes the terms **specification costs or formula costs** (or formulas) are used as synonyms for estimated costs.

Neuner (Cost Accounting) points out that there are two basic reasons for the use of estimated cost procedures: (1) the need to determine selling prices in advance of production, and (2) the desire to reduce the clerical work involved in maintaining a complete cost accounting system.

ESTIMATED AND STANDARD COST DISTINCTION. Both estimated costs and standard costs are **predetermined costs,** but the two can be distinguished in various ways. On the basis of an extensive survey of cost accounting methods actually used, Black and Eversole (Handbook of Cost Accounting Methods, Lasser, ed.) conclude that:

Estimating cost systems cover everything from those based on highly accurate engineering and accounting estimations to what might be called "unreasoned guesses."

At the same time, H. E. Howell (The CPA Handbook, Kane, ed.) points out that whereas standard costs are normally scientifically engineered and established, such precision is not always practical or economical in the case of estimated costs. He goes on to say:

A cost estimate may be an over-all guess, "pulled out of the air," or it may be detailed to the extent of the usual standard cost breakdowns of a complete bill of

material and a labor process or routing sheet. It is often difficult to differentiate estimates from standards if such detailed data are built up.

According to Kohler (A Dictionary for Accountants) estimated costs include standard costs when considered broadly.

Both relate to future operations, and their amounts coincide; however, in everyday usage, the terms may differ in both amount and purpose, the former indicating a projection of anticipated actual costs and the latter a basis with which actual costs may be compared.

Difference in Derivation. Estimated costs are frequently less accurate than standard costs. Standard costs are usually arrived at much more scientifically, being based upon **engineered estimates** and **time studies**, with subsequent verification and confirmation based upon accounting data. In the case of estimated costs, such refinement in derivation is frequently absent. Although this is generally true, it is not necessarily a conclusive differentiation between the two kinds of costs, for estimated costs may be worked out on a scientific basis with a great deal of ingenuity and skill. The matter of accuracy, therefore, is more of a relative than an absolute differentiation between the two types of costs.

The "roughness" or lack of accuracy associated with estimated costs can perhaps best be ascribed to the fact that they are frequently designed for **economical computation** and **operational evaluation.** For this reason various short cuts in computation and other ingenious devices have been applied in arriving at estimated cost data. They may be based upon such devices as statistical computations, correlations, and trend lines. They may also be derived from long-term accumulations of actual costs for various types of operations which closely approximate those that are under contemplation. This is particularly true in such industries as the construction industry. Thus, where subcontracts are estimated in construction for wiring, plumbing, or similar operations, estimated costs of similar but not identical jobs may be the basis of the estimate. This may also be true of the work done by the contractor's own labor force.

Difference in Use. As indicated by Kohler, an important feature of estimated costs is that use is made of them before the extent to which they will deviate from reality is known. **Computations of variances** between actual and estimated costs, therefore, have as their main purpose the refinement of the next set of estimates to be made. Standard costs, on the other hand, are used concurrently with knowledge of their deviations from reality and with emphasis on the control of costs.

Difference in Records. Another difference between estimated and standard costs is the matter of formal record keeping. So-called complete cost accounting systems are predicated upon the assumption that costs are incorporated into a regular **system of accounts** and that by this system formal comparisons are made between the predetermined cost and the actual cost. This sort of formal comparison comes closer to being made under standard cost accounting than under estimated cost accounting. Under standard cost accounting, as explained in the section on Operation of Standard Costs, the records of account usually contain at least a minimum analysis of variances. Under estimated cost accounting, the recording of variances is a less formal one, and whenever they are recorded it is largely for the purpose of correcting inventory and Cost of Goods Sold accounts at the end of the accounting period.

BASIC METHODS OF COST DETERMINATION. The basic methods of cost determination include (1) cost recording, (2) predetermination, and (3) statistical analysis.

Cost Recording. Records are compiled of materials used in production, the incurrence of labor costs, and the accumulation and allocation of manufacturing overhead in expressing aggregate cost of producing goods, either over a specified period of time or over a nonspecified period of time, as in **batch accounting,** in which costs are collected by batches or runs. Costs thus compiled are prorated uniformly over the number of units of production in arriving at **average unit costs.** This is essentially a historical method and is considered by accountants as basic in cost determination.

Predetermination. Costs are computed in advance of incurrence (1) on the basis of past experience as recorded in formal records or (2) from engineers' estimates of quantities of materials, labor, and overhead, and a consideration of the extent to which prices will vary. Sometimes predeterminations are made solely on the basis of statistical analysis of prices and production quantities. In this sense they often become combinations of the use of the formal cost records of a company and an analysis of general market and employment conditions in forecasting what the future direction of costs will be.

Statistical Analysis. In addition to this type of statistical analysis, another basic method of determining cost is the pure statistical approach. This assumes **cost sampling** at various times with a view to determining the possible dispersion of costs, and more particularly their central tendency.

Some consider the statistical determination of a cost as a mere forecast of what the actual cost will be and believe that the statistical process does not express what the cost in fact should be. There is no reason why a cost determined statistically could not be a "should" cost. This, for example, is the case with the use of the **learning curve.** The learning curve, in addition to indicating what costs may be at various times, also permits the expression of what costs ought to be after an organization has had experience with production to some given extent. (See discussion of Learning Curves in Construction in this section.)

COST APPROXIMATIONS. In the past, cost estimating has frequently been considered as a process of making a rough approximation of whatever a true cost may be. Recently, however, by relating mathematical and statistical concepts to the formulation and use of quantitative business data, it has been concluded that it is almost impossible to find a **true cost.** This is due to several reasons. First, there is no one cost. Costs of producing a series of goods or rendering a series of services vary. Although a given series may involve certain trends, actual costs scatter around the trends. If no temporal trend in the direction of costs can be found, it is still true that there is a scatter of costs around some central point. The determination of any central point of costs requires in turn a preconcept of what the **central tendency** actually is. For instance, one must decide what items should be eliminated as unusual or erratic when figuring the central tendency in a group of cost data. Concepts of what is an unusual item change from time to time, depending upon growth in knowledge or the changing need for cost information. Since this is the case, modern cost approximation is something more than a rough estimate; it is a studied computation of what a particular cost is believed to be. This is true whether the cost is averaged, a central cost tendency determined, or the spread of costs among different items at

different times of the day over a succession of months, or in any set of varying circumstances, determined.

Although the major objective of cost estimates is to derive a cost approximation that conforms to the type of thinking behind the need for cost, the more penetrating the cost determination and the nearer it comes to the true cost, the more expensive cost finding is. A cost determination may give a sufficiently close indication of true costs without incurring the needless expense of refinement beyond the point of practical serviceability.

ESTIMATED COST SYSTEMS. A system of estimated costs presumes the establishment of costs in advance of their use. Advance preparation of costs usually precedes the actual taking of orders for the products to be manufactured, or the signing of contracts for products to be fabricated or for construction projects. In either case the price at which goods or services will be offered in the market is, in some respect or other, predicated upon the estimated cost. Thus, if a contractor has an opportunity to bid, he submits his bid on the basis of estimated cost. If a manufacturer contemplates the fabrication of certain items, he compares the estimated cost with what he thinks he can sell the finished product for in competition with other manufacturers. On this basis he either formulates his own price quotations, or if he has limited latitude in doing this, decides whether or not he can afford to manufacture the product under consideration, with prices being what they are and with estimated costs bearing the expected relation to these prices.

Cost Prediction. Estimated cost systems are treated in two general respects in this section. From a broad standpoint an estimated cost system is one by which **business policy** is determined on the basis of cost predictions which have as their ultimate use the formulation of some business decision such as entering into price quotations, making promise of delivery, or providing for the financing of projects to be undertaken in the future.

Cost Recording. On the other hand an estimated cost system is one of cost recording in which estimated costs are involved. The details of such a procedure are discussed under Estimating Cost Systems in this section. The nature of such a system is that cost estimates, which in any case are approximations, are used for recording the completion of goods manufactured or services rendered in order that periodic **financial reports** can be prepared. This is frequently done before an over-all comparison between the estimated and actual cost is possible. When such a comparison is finally made, the estimates are revised, either on a comprehensive basis or by a system of careful examination of those specific phases of the operation for which the estimates appear to be the least reliable. It is generally assumed in this system that there will be no elaborate breakdown of costs.

COMPARATIVE FEATURES. Estimated cost systems are predicated on the assumption that a comparison between estimated and actual costs will be made. This comparison is mainly for the purpose of revising estimates for future managerial use. The purpose of comparison, therefore, becomes less that of explaining what happened in the past and more that of making an intelligent approach to future operations on the basis of revised estimates. This is the major comparative feature of estimated costs as they apply within an industry.

Another comparative feature of estimated costs is the insight into costs being incurred by a competitor for the purpose of determining what price announcements or other managerial decisions should be made. Thus an automobile manufacturer may obtain a new model of a competitive car, take it apart, estimate the

cost of each part, and finally estimate the cost of assembling the entire machine, for the purpose of making a comparison between the competitor's unknown cost situation and his own known cost situation.

EFFECT OF COST BEHAVIOR ON ESTIMATED COSTS. There are a number of factors which markedly affect the behavior of costs and consequently play a significant role in cost estimating.

Cost Classification. Cost elements must be analyzed or broken down into subgroups so that the cost estimator may handle properly the separate elements which make up total costs. The number of classifications into which costs are subdivided depends upon the number of separate elements requiring consideration and increases proportionally.

One of the factors influencing the number of classifications in any given situation is the impact of the type of operation upon the nature of costs. Thus, in a contracting business, consideration is given to costs for materials which the contractor buys and incorporates into the project with his own labor force, costs for his labor and overhead, and in addition costs for the various types of work done by subcontractors. The latter often include such items as excavation, sheet-metal work, plumbing, and electrical work. It is the purpose of cost estimating to reflect in the total cost of the project the behavior of the various applicable elements of cost.

Other elements affecting cost behavior, and thus cost classification, include:

1. Variability of cost.
2. Erratic elements in cost.
3. Central tendencies in cost.
4. Idle time.
5. Spoilage and rework.

Yacobian (NAA Bulletin, vol. 40) indicates three methods of gathering data on cost behavior, namely:

1. The **analytic method.** A review of the chart of accounts, which separates the fixed and variable costs by accounts and by amounts within the accounts.
2. The **historical method.** An analysis of past performance carried out by using statistical correlation techniques which relate each cost component to some measure of activity.
3. The **synthetic method.** The use of engineered standards developed by studies to determine what the behavior of costs should be under certain circumstances.

An understanding of the nature of fixed, variable, semi-variable and erratic costs is important to the individual who estimates costs. A detailed explanation of these costs, primarily from the standpoint of manufacturing overhead, is given in the section on Accumulation of Manufacturing Overhead. Certain additional explanations are given in the section on Cost-Volume-Profit Relationships.

Central Tendencies in Costs. Despite the existence of variances in cost, over a period of time most fluctuations concentrate fairly close to some common level, which is usually referred to as **central tendency.** It is because of this central tendency that businessmen are more inclined to think in terms of average cost figures than in terms of variances. Like other costs determined by the accountant, estimated costs often ignore the dispersion of costs from time to time during the day, from day to day, or from one productive situation to another. Thus, estimated costs are **typical costs.**

This focusing of attention on averages sometimes leads to the spreading of costs uniformly over production. For instance there results a tendency to spread costs

over the actual hours of productive activity. Assuming that a given machine has a total potential operating time of 2,000 hours during a year but that its predicted use is to be only 1,600 hours, the cost of operating the machine is usually spread over the hours of useful production.

Influence of Idle Time on Costs. Many machine or other centers of production often work less than 100 percent of the time on the scheduled work shifts. There are numerous causes of idle time. Among them are both normal and abnormal time lost because of machine failure, maintenance, and repair. In addition, idleness exists when a machine has been purchased to operate for only fractional time. There are other cases where the number of sales orders available permit only part-time operation. Again, machinery or other equipment may be idle because of strikes or the lack of suitable operators.

In the process of estimating costs, normal factors of **downtime** such as normal maintenance, normal waiting for repairs, and normal fractions of nonoperating time are considered as part of the cost of production, thus presuming that downtime does not actually occur. The unusual factors of downtime, however, are excluded in arriving at estimated costs.

Spoilage and Rework as Elements of Costs. When determining estimated costs, spoilage and rework should also be divided into normal and abnormal quantities. Normal spoilage is considered as part of the cost of production. Likewise, rework costs habitually incurred on a relatively few units become part of the regular cost of production. This includes such items as welding weak castings or touch-up work done on the finish of products before they are shipped. Costs of this nature are included, whereas extraordinary amounts of rework or the discarding of products due to excessive spoilage are excluded from estimated costs of production. (For a discussion of spoilage, see section on Materials.)

Uses of Estimated Costs

MULTIPLICITY OF USES. Any one person using estimated costs for a specific purpose may well lose sight of the many other applications possible. Some of the more significant areas in which estimated costs are used include:

1. Setting sales prices.
2. Make or buy decisions.
3. Lease or buy decisions.
4. Budgeting.
5. Preparation of financial statements.
6. Measurement of operating efficiency.

The first three uses are discussed in detail in the section on Special Cost Analyses. The development of budgets is discussed for each of the three elements of cost in the sections on Materials, Labor Costs, and Manufacturing Overhead and Normal Activity. In addition there is a discussion of the general procedures of budgeting in the section on Cost Control, Budgets, and Reports.

PREPARATION OF INCOME STATEMENTS. In the preparation of income statements, the cost of goods sold may be estimated as a certain percentage of sales. In these cases estimated costs are based upon general computations of the relation between cost and selling price. The matter of determining and using costs in such a case is a matter of making statistical estimates of the **sales mix** and forecasting the effect of variations in it upon changes in the rate of markup.

PREPARATION OF BALANCE SHEETS. Estimated costs may have various uses in the preparation of balance sheets. Sometimes estimated costs are used as a basis for extending quantities of **inventories** to determine their total values. In such cases the estimates can be obtained from price quotations or from other computations as to what cost might have been involved in the actual acquisition of the items under consideration. Likewise, estimated costs frequently are used in determining the amount of liability under **purchase commitments.**

MEASUREMENT OF OPERATING EFFICIENCY. In the over-all measurement of operating efficiency, estimated costs may be applied to the number of units produced in order to determine the relationship between total operating cost and total revenue. Conversely, in many situations, the cost to relate to sales price may be estimated from the comparison of the total apparent costs and the possible available production. From this the cost per unit as an indicator of operating efficiency can be derived. Adequate operating efficiency is assumed to be the capacity to produce at a cost sufficiently below selling price to justify continuation of production on the existing basis.

ECONOMY FEATURES OF ESTIMATED COSTS. Any cost system incurs expense for operation. Economy becomes particularly important because of the high cost of clerical work. A theoretically complete refinement of cost information may entail an unduly high expense compared with what the information is actually worth to the business. As a consequence, it is important to find economical ways of arriving at costs.

Estimated costs are economical in the sense that various available short cuts are used in their computation. In other words, estimated costs do not require complete tabulation of all the detailed data. In contrast to making complete tabulations of all sorts of data, estimated costs are based upon such elements as general price quotations, cost tendencies, and data obtained from various sampling procedures. Modern statistical techniques have been tried and used to a sufficient extent to determine the ranges within which reliability may be achieved. An understanding of the degree of possible error in estimated costs facilitates intelligent use of them. The application of such available techniques may be more economical than complete tabulation. In fact, as a general rule, these devices have been designed in order to avoid the necessity of complete tabulation.

Procedure for Determining Estimated Costs

SCOPE AND PURPOSE OF ESTIMATE. Although different situations require some variation in method, there should be a general order of procedure for making cost estimates which is applicable to most cases. The content of the estimate differs as the purpose of the estimate varies. Also, different situations may require varying degrees of accuracy of computations. Greater accuracy demands more than proportionately greater expenditure of time, effort, and other resources. Hence, to avoid needless waste of these factors, it is necessary to establish the scope and purpose of the estimate before analysis and calculations begin.

For example, a cost estimate to establish a minimum selling price on a special order when the plant is operating at less than full capacity could be made on a differential, rather than an average, cost basis. If the cost estimate, however, is to be employed for deciding whether or not to replace present equipment or for the measurement of the efficiency of operations, a different approach must be employed to secure the necessary cost data.

In discussing cost estimates in chemical research, Tallman (NAA Bulletin, vol. 36) says:

We can make estimates varying all the way from rough high-spot, "blue-sky" estimates to more refined estimates in which we attempt to assign a value to each item on the cost sheet.

ESTIMATE COST CARDS. Estimate cost cards or sheets are called the "heart" of the estimate cost accounting system by Blocker and Weltmer (Cost Accounting). Estimates for each element of the product's cost are recorded on a cost card. The type of card varies with the requirements of the individual situation. Lang–McFarland–Schiff (Cost Accounting) show a simple cost estimate sheet in Fig. 1. Vance (Theory and Technique of Cost Accounting) gives an estimate cost card for more complex estimating in Fig. 2. In summarizing the **features of cost estimate sheets,** Lang–McFarland–Schiff state:

Cost estimate sheets commonly provide space for listing the materials that are to be used, the quantities of each, and their cost. If necessary, allowances for scrap, expected spoilage, and rework costs are included. Labor operations to be performed are listed, and hours needed are extended at current or expected wage rates to obtain the estimated labor cost. In order to complete the manufacturing cost, overhead applicable to the order is then added to determine the total manufacturing cost of the order and the cost per unit of product. When the estimate is to be used for pricing, selling and administrative costs applicable are usually added to manufacturing cost

Regardless of the approach used, the procedure involved includes fundamentally the determination of the following:

1. The estimated quantity of each material needed for the given quantity of each product to be manufactured and the estimated price of each type of material.
2. The estimated piece rate or the estimated direct labor hours and estimated hourly wage for each direct labor operation.
3. The estimated overhead cost of each factory activity, expressed in terms such as: dollars per unit of production, per direct labor hour or labor dollar, or per machine hour.

MATERIALS ESTIMATES. The basic elements of estimated costs of materials are the quantities of materials used and the cost per unit, along with an allowance for the value of any **scrap recovery.** For an example, assume that the problem is to determine the estimated cost of materials to be used in producing a particular part out of a single piece of raw material. Eleven pounds of materials are required at the cost of 50 cents per pound. One pound of scrap is recovered, and this can be resold for 10 cents per pound. The materials cost will then be expressed as follows:

Gross materials (11 pounds @ $.50)	$5 50
Scrap recovery (1 pound @ $.10)	.10
Net materials cost	$5.40

Materials Quantity Factors. Gross materials quantity factors may be determined in a number of ways. Vance (Theory and Technique of Cost Accounting) points out that materials quantity estimates may be based on all or any of the following:

1. Engineering specifications.
2. Pilot runs.
3. Records of past performance.
4. Measurement of the materials in the finished product.

ESTIMATED COST SUMMARY

DATE Jan 1, 19— NO. 12345

CUSTOMER Mechanical Products Co

ASSEMBLY DRWG. NO. 6622

PART NO. 67 DESCRIPTION Type "A" Burner

COST PER M PARTS

ON BASIS OF 500

PART NO.	ESTIMATE NO.	DESCRIPTION	NO. OF PARTS	LABOR		MATERIAL	PRIME COST	OVERHEAD		TOTAL COST
				SETUP	OPERATION			ON SETUP	ON OPERATIONS	
6789	12345	Center Bracket	500	4 70	18 07	8 01	30 78	7 34	26 62	64 74
Cost of Parts										64 74
Assembly Labor										16 02
Tool Costs										14 50
Total Costs										95 26

ESTIMATED BY L. H.

Fig. 1. Simple cost estimate sheet.

An examination of these bases indicates that the establishment of estimated materials quantities may be subject to very little, if any, guessing.

Many **materials requirements** are thus arrived at by the inductive process of studying blueprints or other specifications, determining the pattern for using the materials, and combining this knowledge with knowledge of the total number of items which are to be produced. Thus, if it is assumed that ½-inch steel rods come in 16-foot lengths and that bushings ⅞ inch in length are to be cut

MERWIN FURNITURE COMPANY No. 1826

Estimated Cost Card

Product: Dining chair No. 742 **Computed by:** A. J. Shanks

Effective Date: June 18, 19— **Approved by:** O. F. Ladd

Materials

Used for:	Kind	Dimension	Quantity Required	Price	Amount
Legs	Select birch	2 × 2	6′	$0.15	$0.9000
Back sides	Select birch	1½ × 2	3′	0.10	0.3000
Back top	Select birch	1½ × 2	1.25′	0.10	0.1250
Back slats	Select birch	1 × 2	3.75′	0.07	0.2625
Seat frame	Select birch	1½ × 3	5.3′	0.15	0.7950
Blocks	Clear red gum	1½ × 2	2′	0.10	0.2000
Seat board	Fir plywood	¾ × 15″ × 15″	1.56 sq. ft.	0.10	0.1560
Seat cover	Leatherette #72	18″ × 18″	2.25 sq. ft.	0.30	0.6750
Seat pad	Foam rubber 1″	15″ × 15″	1.56 sq. ft.	1.00	1.5600
Dowels	Birch	½″	30″	0.03	0.9000
			Total materials		$5.8735

Labor

Dept.	Operation	Time (Hr.)	Rate	Amount
Cutting	Cut dimension stock	.06	$2.82	$0.1692
	Cut seat board	.002	2.82	0.0056
Shaping	Shape legs	.25	3.15	0.7874
	Shape back sides	.10	3.15	0.3150
	Shape back top	.05	3.15	0.1575
	Shape back slats	.15	3.15	0.4725
	Shape seat frame	.12	3.15	0.3780
Assembly	Seat frame	.22	3.25	0.7150
	Attach legs & blocks	.20	3.25	0.6500
	Attach back sides	.12	3.25	0.3900
	Attach back slats & top	.25	3.25	0.8125
	Cover seat & attach	.15	3.25	0.4875
Finishing	1st coat	.08	2.18	0.1744
	2d coat	.07	2.18	0.1526
	3d coat	.07	2.18	0.1526
	Buffing	.11	2.18	0.2398
		Total labor		$6.0596

Fig. 2. Detailed cost estimate card.

Factory Overhead

Dept.	Direct Labor Hours	Rate	Amount
Cutting	.062	$2.00	$0.1240
Shaping	.670	2.50	1.6750
Assembly	.940	1.25	1.1750
Finishing	.330	1.10	0.3630
		Total factory overhead	$3.3370

Summary

Materials	$ 5.8735
Labor	6.0596
Factory overhead	3.3370
Total manufacturing cost	$15.2701

Remarks: Glue, tacks and paints are accounted for as supplies and included in factory overhead.

Fig. 2. (Cont'd.)

with cutting tools ⅛ inch in width, it is then estimated that 1 inch of material will be required for every bushing that is being cut. The number of bushings which could be made out of each rod of raw material would be computed as follows, making an allowance for a **crop end,** which is the smallest piece of material that the machine can hold while cutting takes place.

Length of rod (in inches)	192
Crop end (in inches)	6
Number of inches available	186
Number of bushings (1 per inch)	186

This process of induction is used to a great extent in the **metal trades** and in various **textile industries.**

When it comes to estimating quantities of materials for products such as are found in the packing of animal or vegetable products, a process of deduction from statistical sampling and analysis can be used. For example, the number of cases of corn which can be canned from a ton of corn as it comes from the field on the cob and with husks on it may require determination. The quantity of pack obtainable may be estimated from statistical samples which have been obtained in the past with relationship to such elements as moisture content, thickness of husk, and other factors, including variations in the different varieties of corn. With these samples and with the variation in the pack that can be expected, the quantity of product which would be obtainable from any given quantity of available material may be estimated within a certain latitude, making an allowance for error.

The **canning industry** also makes a series of estimates of materials quantities available for packing as **crop estimates** are refined during the progress of the crop year.

Materials Price Factors. Tallman (NAA Bulletin, vol. 36) indicates that one of the major stumbling blocks in the estimating of cost is encountered when trying to price raw materials. This is especially true, he points out, in the case of **new**

products, *where the raw materials are not currently available on a commercial basis and therefore firm prices are not obtainable.*

Estimates of materials prices come from various sources. Sometimes a price has been established by contract for a given length of time, such as is the case when a fruit packer contracts with growers for the purchase from the trees of fruit at a set price per ton, with this price applying for the entire year's crop. In the case of materials which are to be purchased from time to time, subject to existing market prices, however, the estimated price must be predicated on **published quotations** and other indicators of what the price may be. In these cases the shorter the period in advance, the more nearly can current price quotations be used as estimates. The longer the period that costs are estimated in the future, the more necessary it is to forecast the price from trends and from forecasts of price trends.

Expected future prices or cost trends of materials are available to the cost estimator through trade journals and daily newspapers. He may also, of course, use the judgment of the manufacturer's own purchasing department personnel.

Materials Scrap Factors. Materials scrap allowances are determined by estimating the quantity of scrap which will result from the manufacture of a given product. In situations where materials requirements are estimated by mathematical induction, the quantity of scrap is determined by the amount of expected cutting wastage. This is fairly simple in the case of making items from rods or wires on standard machinery with standard cutting tools. The scrap consists of the crop ends plus the amount of wastage created by the cutting tool. In the case of items made from sheets of metal or strips of cloth, a pattern is designed for the cutting that permits the most economical use of the entire sheet or strip. (See section on Materials.) **Wastage** is determined quantity-wise from whatever materials remain. This includes areas that are cut out between irregularly shaped pieces of product and those crop ends that are too short for the cutting of additional pieces of product.

In the case of certain **analytic industries,** the amount of scrap may have to be determined inductively. Statistical sampling is frequently used to indicate what the amount of wastage should be. In the canning industry this would include the hulls of peas which can be resold for feed, and in the dairy business it may include the amount of whey which can be either disposed of directly or processed further.

In most cases the quantity of scrap materials or, as occasionally termed, **by-product materials** recovered is multiplied by the expected market price to determine the estimated dollar recovery. Theoretically it is possible to consider the sale of scrap as being made at a profit or loss, presuming that an intelligent allocation of cost of scrap can be made. Such a theoretical possibility appears to a certain extent to be impracticable. An alternative method, and perhaps the more practical approach, establishes the value of scrap at a **break-even point,** that is, a point at which the scrap is presumed to be sold at a price equal to its cost. The ultimate result of this procedure is that the cost of the main (that is, the desired) product is reduced by the amount of recovery from the sale of scrap.

LABOR ESTIMATES. Estimating labor cost, as emphasized by Matz–Curry–Frank (Cost Accounting), is more involved than estimating materials cost. The estimator must have an understanding of all operations to be performed. In addition, as Vance (Theory and Technique of Cost Accounting) points out, the labor quantity factor is dependent upon the skill of the individual worker and his work on the job.

Estimated labor cost is usually determined in one of two basic ways. It can, in the first instance, be determined on a **piece rate** which may have been arrived at through negotiations. In such a case the labor cost is determined simply by multiplying the rate by the number of units to be produced. In still other instances labor cost is computed at a certain **rate per hour.** In such cases cost per hour must be divided by the number of units to be produced per hour in order to obtain the labor cost per unit.

Labor Quantity Factors. The quantity of labor is particularly important on nonpiece-rate jobs, where it must be determined and multiplied by the labor rate in arriving at total labor cost. In making such a determination of the quantity of labor, it is necessary not only to know the actual labor time spent on production itself but also the time required for set-up, materials handling, machine repair, and similar elements which consume labor time.

It is equally important in labor quantity computations to determine the hours for which **overtime rates** apply. It is frequently assumed that if labor is to be paid on a piece-rate basis, labor cost can be determined without reference to labor time. This is a superficial view with respect to labor cost, however, since a number of related factors depend upon the amount of labor time. The amount of work which has to be done on an overtime basis with overtime **premium** is one such important element.

Labor Rate Factors. A variety of viewpoints may be considered with respect to the labor rate to be used in estimating cost. Sometimes the labor rate is thought of as a specific amount per hour on which the employee's compensation is based. When such a rate is used, it is necessary to include social security and other **fringe benefits** of labor.

Sometimes, instead of determining fringe items separately, they are included along with the hourly rate of the employee in establishing the rate to be used in computing total labor cost. In such a case the rate can be determined as follows:

Rate of pay per hour (contractually determined)	$2.1000
FICA (employer's 2½ percent)	.0525
Unemployment compensation (appropriate rate)	.0210
Workmen's compensation (appropriate rate)	.0120
Total labor rate per hour	$2 1855

Labor Piece-Rate Costs. Another concept sometimes used in estimating labor cost is the **labor piece rate.** A labor piece rate often is used directly in estimating the labor cost per unit of product. Thus, if a piece rate is $7 per thousand, the labor rate factor is considered as $7 per thousand.

Labor piece-rate costs in themselves are frequently poor indicators of the actual labor cost per unit of production. It is preferable to adjust a labor piece-rate cost for other factors such as overtime, fringe benefits, and other such costs to arrive at a revised piece rate per unit of production. Otherwise the labor piece rate should be converted into an hourly rate, showing how much is earned per hour This is especially important where workers are not paid entirely on a strict piece-rate basis although they are apparently on a general piece-rate basis. For one thing, a piece rate may be an **escalator rate** that is, one with higher rates of pay for portions of or all of production as the quantity per unit of time increases. In addition there may be special allowances, such as straight time pay for idle time, which needs to be considered along with actual productive running time. These and other elements encourage the conversion of piece rates into **revised hourly**

rates that reflect all the labor costs per production hour. Such derived hourly rates can then be related to production for improved estimated costs.

This procedure is to be preferred over the alternative of computing a revised rate in any instance where a worker divides his time among a series of different sizes or items of production at varying rates of output per unit of time.

In general it is assumed that the establishment of either an hourly rate or a revised piece rate, which takes into consideration some of these other elements, is much more suitable in cost estimating than the use of either a straight hourly rate or a straight piece rate.

MANUFACTURING OVERHEAD ESTIMATES. Manufacturing overhead costs need to be evaluated according to several criteria. In the first place, manufacturing overhead costs frequently are segregated according to the **degree of variability,** ranging all the way from those that are completely fixed to those that vary directly with production.

Another classification of manufacturing overhead costs is made according to the **distribution method,** by which they are allocated among the various elements of production. Thus, certain elements of overhead can best be apportioned according to the quantity of labor involved. Other overhead elements may best be allocated according to the number of machine hours of operation, while still others may best be distributed according to the extent of usage of floor space for any productive operation. It is important that these segregations and allocations be made to suit the productive situation actually involved.

Estimating Variable Overhead. The process of estimating variable overhead is one of predicting its **fixed relationship to production.** For instance, it may be possible to determine the amount of fuel needed to heat a given furnace. Since production controls the amount of heat in the furnace, the estimate becomes a matter of predicting the purchase price of the amount of heat to be used. There is also the assumption of the constancy of the relationship of heat to be used, which in essence is actually a prediction of the rate of efficiency of the furnace using the heat. Similarly, other elements of variable overhead can be estimated by determining the relationship of the physical quantity to the projected item of production.

Estimating Fixed Overhead. Since no definite relationship exists between the amount of fixed overhead and any particular item of production, the estimating of fixed overhead is primarily one of determining the over-all amount. Many items of fixed overhead require only the simplest degree of estimation. Thus an item of **rent** for a factory site requires only an examination of the rental agreement in order to determine the amount of rental payments per period. Some other items of fixed overhead, however, lend themselves to somewhat less definite determination. Estimates for the amounts of **insurance,** for example, depend upon what possible changes may be made in the insurance policies during the course of the period under estimate. Estimated **property taxes** are, to a certain extent, not only a prediction of what the tax rates will be but also as to what the assessments may be. An estimate of foremen's or superintendents' **salaries** can be determined by examining the salary arrangements that have been made with the individuals involved. The only factor of estimation here is the matter of predicting whether or not the salaries will be changed during the period under estimate. The aggregate of fixed overhead is the sum of the estimates of the individual fixed overhead items.

Estimating Semi-variable Overhead. There are various elements of the semi-variable overhead costs which need to be estimated. It is important in connection with estimating such items that the points of variation be determined. This is true because semi-variable overhead assumes the nature of fixed overhead between points of change. (For further discussions of manufacturing overhead, see the sections dealing with its various phases.)

Tooling Costs. The cost of tooling up for a particular job is often best considered as a separate item of overhead because of the special size and nature of the cost elements included. For instance, when certain metallic shapes are ordered from a rolling or drawing mill, it is customary for the customer to absorb the cost of the rolling or drawing dies. The **die cost** may be a large amount and should not be charged to general overhead. Likewise, if special sizes and shapes are needed for a given job, it is better to compute the cost of the dies as a separate item to be added to the particular job cost.

In certain cases **special tools** are required in order to carry out the work for a customer. Such costs should be estimated and billed separately to the customer on the basis of the cost estimate. This type of separate estimating and billing procedure for tooling is regularly done in modern industry.

The first phase of estimating tooling costs is to approximate the type and quantity of tools needed. This is true regardless of whether the tooling is the simple acquisition of a set of dies for a limited operation or whether it is a major operation such as that required when shifting from one year's model to the next.

Bid prices by outside suppliers are simple sources of tooling costs. Cost of tools constructed by a firm's own labor force is estimated in the same manner as cost of products destined for sale.

Overhead Application. It is necessary that the application of estimated overhead be on a basis that enables the distinguishing of the various cost levels that apply to the utilization of different machine or other **cost centers.** Thus overhead may not be applied strictly on a machine-hour basis under all conditions. It is by observing the nature of the items of overhead to be allocated that a suitable basis of allocation results.

The degree of precision desired in the final cost figure is an important element in determining the method of assigning overhead. For example, it often happens that a given operation can be performed in more than one way, by the use of alternative methods or equipment. If, however, the scheduling of other work happens to encompass the entire available time of certain items of equipment, the costs must be reckoned in terms of alternative methods or available equipment. Since there is bound to be some difference in costs of various methods, an accurate cost estimate must take into account the amount of work already scheduled. But if the estimate need not be so precise, costs may be reckoned in terms of the method ordinarily employed for such production.

As Matz–Curry–Frank (Cost Accounting) state with regard to new jobs:

> Manufacturing expenses applicable to the various orders or products are usually based on the use of a predetermined burden rate. In instances, however, where an order or job constitutes new or unexpected business, the estimator should not use the regular burden rates. To do so might penalize the new job considerably and make any comparisons between actual and estimated figures difficult. It is therefore desirable to prepare a new burden rate based on the individual manufacturing expense items that enter into the new order or job, such as heat, light, power, supplies, indirect labor, depreciation, and tools. These expenses should be segregated from the regular operating overhead.

PRICE CHANGES. In connection with estimating costs, the problem of allowing for changes in prices, for materials, for wage rates, or for the prices of various items that influence overhead rates is encountered. Such price changes may apply for the period during which estimates are to apply. These changes will not necessarily reflect the actual long-run trend of prices. For this reason the concept used here refers to **anticipated price changes** rather than **price trends** as such.

Materials Price Changes. Estimated materials price changes are determinable from a multiplicity of sources, depending upon the nature of the materials involved. In the case of certain metals such as steel, aluminum, and copper, the estimated future prices and any changes which may occur in them are best determined from such appropriate **trade sources** as the suppliers themselves or from institutes of the suppliers. If the raw materials happen to be raw products that enter into the processing of fruits, vegetables, meats, and similar items, the sources may be various crop and **production reports** as well as **quotations** on organized commodity and livestock exchanges. If the raw materials consist of various subassemblies or manufactured parts, the best indicators of future prices may be contracts which the manufacturer has placed with his suppliers. In any case firm contract commitments for future deliveries may be used as indicators of prices.

Wage Rate Changes. The possibility of a given wage rate changing during the period being estimated is to a great extent dependent upon whether or not the wage rate under consideration is in the pre-negotiation, negotiation, or post-contract stage. Obviously, once a contract has been made, wage rates are known with reasonable certainty for the period covered by the contract. If an organization is still in the contract negotiation stage, the eventual effect on wage rates may be estimated by the trend of negotiations. If an organization is in the pre-negotiation stage, the matter of estimating future wage rates may depend upon how other wage contracts are going and what tendencies there are toward changes in wage rates in other areas. Useful data in this respect are available in the Monthly Labor Review of the Bureau of Labor Statistics, United States Department of Labor.

Overhead Rate Changes. Changes in overhead rates as they are applied either to cost centers or to products are the effect of both quantity and price changes. It is the purpose here to observe only the effect which price changes may have on overhead rates.

Price changes influence overhead rates, due to general changes in the price level and also due to changes in the prices of specific items entering into overhead costs. Prices of **fuels** such as gasoline and fuel oils fluctuate. The same is true of the prices of **small tools.** Similarly there can be changes in rates of wages for **indirect labor** and revisions in **power rates.** These and similar price changes must be estimated by reference to knowledge of the specific situations which apply and must be considered when determining overhead rates.

Application of Estimated Costs

INDUSTRIES USING ESTIMATED COSTS. Newlove (Process Costs) states, "Estimated cost systems are particularly useful in industries in which the element of style is predominant and in which it is necessary to make up samples, quote selling prices, and take orders far ahead of the actual manufacturing. Estimating cost systems are especially useful in strongly unionized industries in

which contracts are in force fixing rates for work and conditions of employment for definite periods of time." Matz–Curry–Frank (Cost Accounting) indicate that estimated cost systems are found in a great variety of industries, both synthetic and analytic, such as:

1. Manufacturers of shoes, furniture, and clothing.
2. Organizations engaged in construction work of all kinds, such as roads, bridges, shipyards, houses, offices, and plant structures.
3. Companies in the fields of bottling, candy making, medicine, bakery, and canning.

Schlatter and Schlatter (Cost Accounting), define an **analytic product** as one of the several made from one raw material. For example, gasoline, kerosene, paraffin, and many other products are made from one raw material, crude oil. In contrast, a **synthetic product** is made by bringing together a number of different materials and parts. Whereas synthetic production includes the manufacture of such products as shoes, furniture, and clothing, analytic production includes the processing of such products as meat, tobacco, and canned fruit.

SYNTHETIC INDUSTRIES. Estimated costs can be used in several different ways in synthetic **manufacturing industries.** First, they can be used as the initial expression of what it would cost to produce a particular product. The estimated cost is compared with the probable selling price to determine the feasibility of manufacturing and marketing the product. Secondly, it is possible that the same cost may become the basis of cost recording in the company's official records, as described under Estimating Cost Systems in this section.

Estimated costs are used in the **construction industry** primarily in connection with bidding for jobs. Construction plans and specifications normally are made available to qualified bidders. On the basis of the plans and specifications, estimated costs are developed to serve as the basis for bidding. The bid price tends to be the estimated cost plus the desired profit.

This procedure is used extensively in the building industry and is also used widely in air-frame construction. In the case of the latter, the **learning curve**, or some similar statistical tool, is frequently used in determining the estimated cost.

ANALYTIC INDUSTRIES. A good illustration of the use of estimated costs in **continuous process** analytic industries applies in the canning and packing of a fruit crop. An entire fruit crop is broken up into the various grades of fruit, which in turn are canned in various sizes of containers. The development of cost estimates in such an industry involves the determination of the costs of packing all grades and the allocation of such estimates among the various grades of pack. The total estimated cost is compared with the estimated income from the pack.

Such estimates are formulated early in the crop year, to supply preliminary ideas of operational profitability and to serve as source material for the preparation of preliminary budgets. Both **profit estimates** and **budgets** go through a series of revisions as fast as refined crop production and packing cost estimates are available. These estimates are ultimately compared with actual operating figures as a final step in profit determination, but operational planning and control have already occurred on the basis of the estimated costs.

An illustration of the application of estimated costs to a single **batch job** of analytical work is readily found in the wrecking and salvage industry. A contract called for the wrecking of a building or the dismantling of a ship is based on the estimated cost of doing the job. Allowance is made for salvaged materials, and a bid (allowing for the desired profit margin) stems from the estimated cost of

wrecking or dismantling. In such a case estimated costs directly relate to the specific job at hand.

Estimating Costs in Manufacturing

ESTIMATING PRODUCT COSTS. The basic concept with respect to the estimating of product costs in synthetic industries involving manufacturing is that the **cost of production** should include:

1. An estimate of the quantity of materials needed at the applicable purchase price.
2. An estimate of the necessary labor hours at the wage rates presumed to be effective when the production is to occur.
3. An estimate of the applicable manufacturing overhead.
4. An estimate of any subcontract work which applies in connection with a particular production job.

This concept best applies in production situations where labor is either of the **assembly line** type or is restricted to one or a few simple operations. The estimating process in these cases becomes one of estimating materials, labor, and manufacturing overhead for each relevant volume of production, as has been set forth under Procedure for Determining Estimated Costs in this section.

One of the more useful approaches to the estimating of product costs is one approved by certain trade associations for arriving at **price quotations**. Under this approach, the estimated product cost consists of an estimate of the net materials to be used, plus an estimate of a series of operational costs determined by relating machine speeds to cost center rates. When using this method, the estimated product cost comprises the net materials to be used plus the cost of the sequence of operations necessary to effect completed production. This approach is illustrated in Fig. 2 by Vance (Theory and Technique of Cost Accounting).

The cost of **final assembly** is frequently a significant production cost in synthetic industries. Such a cost is superimposed on the estimated cost of the various components that enter into the assembly and it includes both the cost of assembly and packaging.

ESTIMATING MACHINE HOUR RATES. A synthetic manufacturing industry involves the production of goods with the use of a series of related machine or operation groups which are called **cost centers**. In a number of cost systems there has been a tendency toward the superficial establishment of rates, with an excessive uniformity of the various cost-center rates. Such a procedure frequently does not provide adequate differentiation among the costs of performing various operations.

One serious deficiency in such a system is its inability to provide appropriate data for the appraisal of **individual cost-center rates** from the standpoint of effective cost control. If only a single product is manufactured, the erroneous concentration of estimated cost-center rates may not cause serious difficulty in the pricing of the product. If multiple products are being produced under such a situation, however, serious difficulties could be encountered in the pricing process. This is expressed by F. S. Howell (NAA Bulletin, vol. 32) when he says:

> Early proponents of the benefits of cost accounting advanced as a warning example the hypothetical case of a job shop with operations falling into three clearly defined classifications: sheet metal working, precision machining, and bench assembly. The hypothetical owner of this hypothetical shop, out of (hypothetical) sheer ignorance, utilized an all-embracing overhead ratio in bidding on work which came his way. As

a result he was, on one hand, occupied in fighting off customers clamoring for machine work to be done and, on the other, equally occupied in fending off the sheriff. There then appeared on the scene a cost accountant, likewise hypothetical, who demonstrated clearly and forcibly the necessity of departmentalizing overhead rates for cost estimating purposes. After this both the shop owner and the cost accountant lolled about in hypothetical wealth.

Each machine hour rate (or cost-center rate) involves the combined costs of applicable labor and manufacturing overhead. The labor elements consist of the cost of the human effort applied specifically to the operation of the cost center. In the case of machines this includes the machine operator and any assistants that may be needed to get the production out of the machine. In the case of a cost center such as an assembly line, it consists of all the persons directly engaged in the assembly of the product. (For a detailed discussion of manufacturing overhead rates, see the section on Manufacturing Overhead and Product Cost.)

TOTAL ESTIMATED PRODUCT COSTS. Once machine hour or other cost-center rates have been established, it is comparatively easy to arrive at the total estimated cost of a product. This consists of the cost of the materials required, plus the cost of performing the various operations necessary. Thus, assuming the publication of a pamphlet (the production cost of which includes the cost of paper, linotype operation, printing, folding, cutting and covering, stapling, and packaging), the cost per thousand could be estimated as follows:

Pamphlet X

Cost per Thousand

Paper	$100
Linotype	100
Printing	50
Folding	50
Cutting and covering	60
Stapling	30
Packaging	20
Total cost per thousand	$410

DESIGN COSTS. Design costs include those costs involved in the development of a product. They encompass such areas as research experimentation and other similar elements of cost which are incurred in designing a particular product or a particular model of a product. In estimating product costs, the total estimated cost of such **product development** is divided by the estimated units of production to which the cost is applicable to determine the per unit cost of design.

If such a cost is substantial, it normally appears as a separate item in the estimated cost of the product. If such a cost is to be spread over a large number of units of production, however, it is frequently prorated as an element of general manufacturing overhead. For instance, the cost of designing a particular bearing or crankshaft for a specific machine is usually considered as part of the cost of the machine. On the other hand, the cost of designing an identification badge which is to be produced in large quantities is normally considered as part of general manufacturing overhead.

SPECIAL TOOLING COSTS. The estimating of tooling costs varies with the nature of the production activity in which a particular business organization is engaged. If tooling is undertaken for a product which is to be mass-produced

over a considerable period of time, the cost of tooling may be allocated to general manufacturing overhead either on a time or unit-of-output basis.

In other situations a business organization may be called upon for a **price quotation** on certain jobs which require the use of tools specifically designed for the proposed contract. For instance, **special tools** are often required in the case of dies for the drawing of specific structural shapes or the rolling or drawing of materials to certain dimensions. In situations of this nature, negotiations are based (at least to some extent) upon the estimated cost of such tools. This is true regardless of whether the customer receives a specific quotation on the tools or whether the tooling cost is included in the over-all price quotation.

In either of the above situations, separate estimation of tooling costs assumes importance because of the high degree of variation of tooling among different jobs that may be undertaken. Some jobs may require little or no tooling, while other jobs may require a tremendous amount. Where such possible variation occurs, it is unwise to follow blindly the procedure of including all tooling costs in general overhead because the estimate for tools for some jobs would automatically be too low and could thus encourage the acceptance of unprofitable business. On the other hand, overstatement of estimated tooling costs by the use of an over-all overhead rate could result in the loss of desirable contracts. This distinction increases in importance proportionally to the percentage increase of tooling cost for a job. Tooling cost assumes a high percentage of cost in cases where intricate and high-priced tools are required for production runs of relatively short duration and small size.

SET-UP COSTS. Similar to the matter of tooling costs is that of set-up costs. In situations where price quotations are desired for productive operations which require special set-ups, the price quoted must allow for set-up cost. Such cost includes the cost of labor involved, plus applicable overhead. An **hourly set-up rate** may be determined and used. The hourly rate multiplied by the estimated number of hours necessary for the set-up operation establishes the estimated set-up cost for any given situation.

Estimating Costs in Construction

NATURE OF CONSTRUCTION. For the purpose of estimated cost accounting and cost control, construction operations include the processes of erecting or otherwise providing structures such as buildings, dams, and roadways. They also include the fabrication of ships, airplanes, and other specific items of heavy equipment.

A peculiar feature of construction is that the amount of work to be done on any one item or unit occurs over a prolonged period of time, in contrast to the relatively short period of time that goes into the manufacture of a given unit in an ordinary manufacturing process. Thus a company constructing airplanes may build relatively few units over a year's time, whereas in the manufacture of identification badges, millions of individual units may be produced over the same period of time, with each unit consuming only an infinitesimal portion of the entire year's productive time.

Construction in most instances is done according to **special plans and specifications.** Thus the construction of a dam or building is usually done according to a specific set of plans which are designed for that structure only and which are specifically intended to fit the structure into the particular site to which it applies. Similarly, in the case of airplanes, relatively few are built according to any one

set of specifications. In fact, as construction progresses, improvements are frequently introduced in the form of specification changes, so that even the few individual units in any one construction contract will occasionally reflect differences in their finished form.

In construction it is frequently the case that no identical item has been made before, and therefore any prediction of cost must necessarily be a cost estimate.

CONSTRUCTION VS. MANUFACTURING. There are important essential differences between construction on the one hand and manufacturing on the other. Manufacturing includes the production of items that are numerous and generally similar, either over prolonged periods of time or in **batches** or **job lots** consisting of a large number of relatively small units which are as nearly identical as it is possible to make them by modern precision manufacture. Therefore, in the case of manufacture, the frequent repetition in production gives some degree of opportunity to revise estimates of cost to arrive at improved knowledge as production occurs. This may be true whether or not it is possible to revise the selling price. In the case of batch work, where one would know the actual cost and hence be able to compare it with the estimated cost only when the job has been completed, it is nevertheless true that each individual item of production is relatively small and has relatively few components. This is in direct contrast to what is found in the construction industry.

Since construction is so complicated per unit and occurs over so long a period of time, as is usually the case, cost estimating may be very cumbersome, either relative to the time allowed for making a price quotation or in the very nature of making the estimate itself. This emphasizes the seriousness of arriving at dependable estimates. Frequently **construction quotations** must be made in a very short time as compared with actual construction time itself. Price quotations also take the form of competitive bids. If cost estimates are too low, there is a danger of being awarded a contract at a loss. If the cost estimates are too high, attractive business may be lost to others who have either correctly or incorrectly submitted lower bids on the basis of lower estimated costs.

MATERIALS CONSTRUCTION COSTS. Materials costs for construction include the two basic variables of quantity and price. Sometimes materials quantity lends itself to **mass computation.** For instance, in the construction of airframe the total sheet metal requirement is best determined by using the ratio of metal requirement to a total tonnage of airframe. Aggregate lumber estimates in construction may be figured as the number of board feet for the total square footage of either floor, walls, roofs, or other portions to be covered. Concrete requirements can be determined by using the number of cubic yards of fill called for. These naturally are estimates but frequently can be made within narrow limits for error.

Estimated prices during construction are forecasts of prices at the time materials are to be purchased or contracted for. Materials prices may be estimated with close approximation if it is possible to consummate a firm contract for the delivery of the materials or if it is possible to make an immediate purchase for the acquisition of the entire lot of materials necessary for the project under construction. When materials are to be delivered over a prolonged period in the future without any contracted price, however, estimates must be made of possible price variances in arriving at the estimated cost per unit of materials.

CONSTRUCTION MACHINERY AND EQUIPMENT. Special machinery and equipment are frequently required for a given construction job. The cost

of machinery and equipment so acquired is part of the estimated cost of construction. Consequently cost estimating requires a knowledge of what machinery and equipment will be required for a particular project. This may include trucks, bulldozers, tractors, and cranes, for example. Estimated costs of items such as these are obtainable from current **price quotations** or from **contracts** for the construction of special items of applicable equipment. If the contractor makes his own equipment, the estimated cost is determined in the same manner as for the fabrication of products for resale.

LABOR CONSTRUCTION COSTS. The quantity of labor required for construction today, when so much of construction work is done by machinery, is primarily dependent upon the amount of labor required to keep the machines in operation until completion of the project. Such labor requirements, when multiplied by the rates of pay per hour and adjusted for estimated hours of overtime and additional charges for fringe benefits, become the estimate of labor cost for the project.

OVERHEAD CONSTRUCTION COSTS. Construction overhead costs include those items of cost associated with a particular project other than the costs of materials and labor which specifically enter into the construction. Overhead costs for construction include such items as gasoline used in operating the trucks and tractors, materials used in building forms for pouring concrete, materials used in the process of welding, and small tools. Overhead items of this nature are estimated and charged directly to the particular project.

In addition a certain portion of so-called **administrative overhead** is normally added which is not directly applicable to a specific project if there are multiple jobs in process at the same time. Overhead of this nature is composed of the costs of administering and planning a job rather than the actual performance of work on the site of the construction project. Such items of overhead are usually estimated as a certain percentage of the costs of materials, labor, and subcontract work going into construction. The rate normally is predicated upon previous experience. If the contractor lacks previous experience upon which to base his estimate, he must estimate the magnitude of such items or use published typical figures normally available from builders' and contractors' associations.

SUBCONTRACT COSTS. The **prime contractor** normally sublets much of a given contract to subcontractors, including such jobs as painting, plumbing, installation of heating systems, installation of hardwood flooring, and concrete finishing. Instead of estimating the costs of these, he in turn solicits bids from **subcontractors** so that he actually knows the cost to be incurred for these contributions to the completion of the construction. The subcontractor, on the other hand, needs to estimate the cost of his performance, and to the extent that he does this, his job of estimating costs becomes similar to the estimating of costs by the prime contractor himself. As pointed out by Hamm (Encyclopedia of Accounting Systems, Williams and Doris, eds.):

> Estimating is of prime importance to the financial future of the plumbing and heating contractor. Each job must be estimated thoughtfully and thoroughly, for no two jobs are exactly alike.

CONSTRUCTION TIME SCHEDULES. Time schedules used in construction are in themselves estimates. Within certain limits, **performance time** on a given construction contract may have relatively little effect upon the total cost of

the particular contract. If the time requirement were unduly shortened, however, additional costs would have to be estimated for overtime and other special rush premium payments. Conversely, if the time for completion extends substantially beyond the usual range of acceptability, extra costs for delays (such as interest on borrowed money) add to the cost of construction. In some cases penalties must be paid to customers for each day delayed.

LEARNING CURVES IN CONSTRUCTION. One of the most significant developments in estimating construction costs has been the growing use of the learning-curve technique. This is particularly true in the construction of aircraft, but the basic elements of the learning curve are adaptable to wider areas of

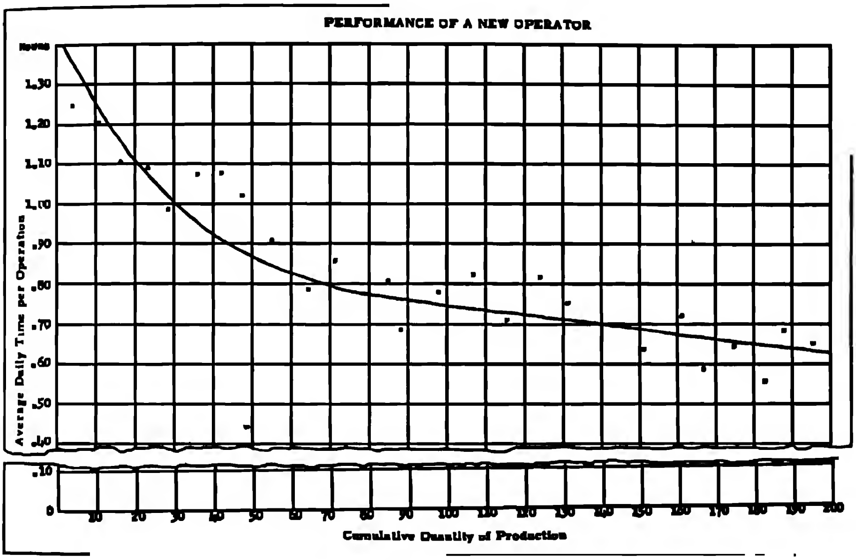


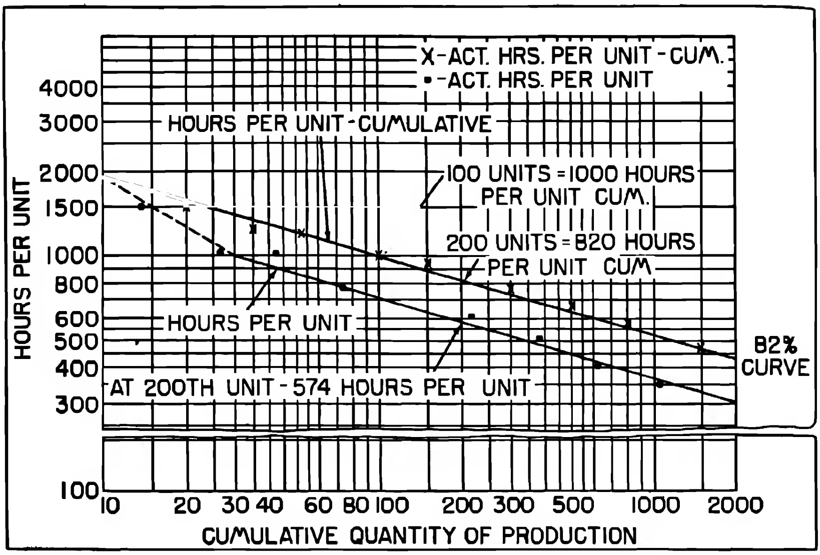
Fig. 3. Learning curve of new operator.

activity. Jordan (NAA Bulletin, vol. 36) points out that the learning curve has become an accepted tool in industry for projecting **shop loads**, determining **man-power requirements**, and negotiating **subcontracts**. It is used by the armed forces, particularly the Air Force, to determine the reasonableness of quotations received.

The theory of the learning curve, as described by Jordan, is that whenever the total quantity of units produced doubles, the **cumulative average cost per unit** declines by a constant percentage.

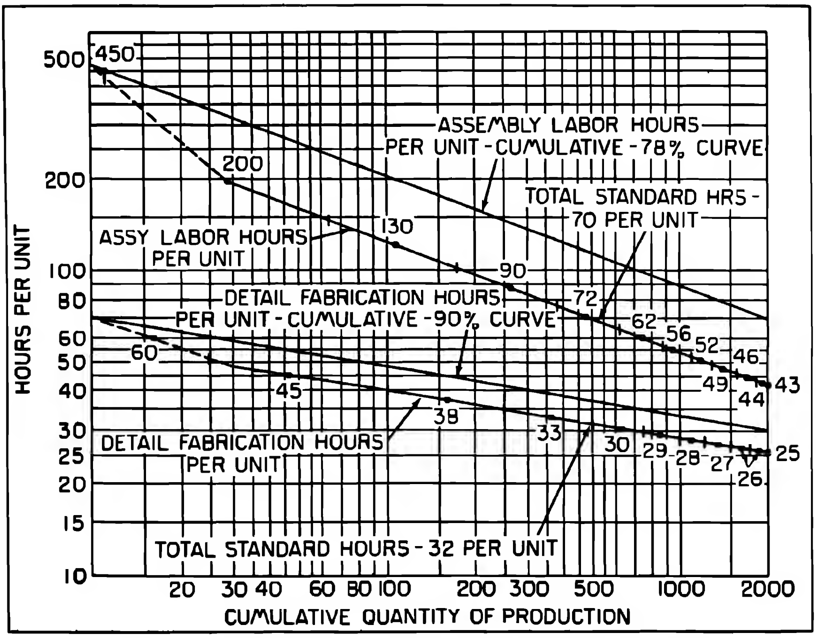
Wyer (NAA Bulletin, vol. 35) describes the basic thinking behind the curve by first citing the experience of a single operator as his proficiency increases with the experience gained by continuous production experience. As his cumulative experience increases, his average daily time per operation decreases, as illustrated by Wyer in Fig. 3.

Studies in the aircraft industry have indicated that a rapid reduction in cumulative average hours per unit is possible. As a consequence it is translated into curves that reflect the expected drop in the cost of constructing successive units



Plotting a learning curve from actual cost data (log-log scale).

Fig. 4. Aircraft industry learning curve.



Detailed learning curves for estimate of exhaust cones (log-log scale).

Fig. 5. Learning curve of a detailed fabrication and assembly of components.

of aircraft. The following tabulation from Wyer (NAA Bulletin, vol. 35) shows an 80% learning curve:

80 Percent Learning Curve

Quantity of Production	Cumulative Average Unit Labor Hours
1	1.000
2	0.800
4	0.640
8	0.512
16	0.410

Wyer also gives a curve, based upon an 82% experience, in Fig. 4. The straight line for "Hours per Unit—Cumulative" indicates the constant rate of reduction in cumulative average labor hours.

A similar learning curve may be used in predicting the cost of the *n*th plane to be constructed. Similar computations and curves may be used to determine the expected cost for various aircraft **components**. With the different learning curves which apply to each component, it is possible to estimate the cost, including the labor time for the assembly and fabrication of separate components, and thus determine the different rates of applicable labor that will be required for production. Wyer illustrates curves for detailed fabrication and assembly that may apply in a given situation in Fig. 5.

Estimating Costs in Analytic Industries

NATURE AND DEFINITION. Although estimated costs are used in a variety of synthetic industries, they are also used in numerous analytic industries. In **analytic industries** the product is one of several made from one raw material, as opposed to **synthetic industries** in which the product is made by bringing together a number of materials and parts. Although the basic problems in cost estimating for the various elements of cost are similar in both synthetic and analytic industries, most analytic industries have their own peculiarities from the standpoint of estimated costs.

CONTINUOUS PROCESS ANALYTIC INDUSTRIES. An analytical product may be processed by using either a continuous-process or a job-lot method of production, but as pointed out by Schlatter and Schlatter (Cost Accounting), practically all analytical products are produced by the continuous-process method. For example, this method is generally used in such industries as canning, tobacco, and meat packing.

The importance of estimated costs in the **canning industry** is accentuated by the practice of purchasing the raw product at a flat rate per ton, with the possibility of many grades of finished pack coming out of any given ton of raw product.

Regarding this practice, Blocker and Weltmer (Cost Accounting) point out that:

> Fruit for canning is generally purchased at a flat price per ton, but out of a ton of fruit will come many grades of finished pack. The cost of the raw product cannot be charged at a uniform price per pound to the various grades because the selling prices on the lower grades are not high enough to return the average price per pound on the fruit canned. Thus the better grades must be charged for more than average price to make up for the deficiency in the lower grades.

JOB LOT ANALYTIC INDUSTRIES. As indicated by Blocker and Weltmer (Cost Accounting), a number of manufacturing concerns which employ job-lot cost accounting methods have found it advantageous to use estimated costs.

The importance of a particular peculiarity in the manufacture of **wood products** is emphasized by Noltemeyer (NAA Bulletin, vol. 36) in discussing the problems involved in estimating lumber costs:

> Above all other cost elements, it is of utmost importance that the true lumber cost be accurately predetermined in the preparation of cost estimates. This factor may represent from three to ten times the dollar value of other cost factors making up the total cost of an item.

According to Noltemeyer, the only way to prepare sound estimates for wood products is to develop **estimating charts** from which estimators can determine costs for frequently produced items. For items not regularly produced, estimates must be developed in terms of the operations involved.

Short Cuts in Estimating

COMMON SHORT CUTS IN ESTIMATING. Some of the more common short cuts used in estimating are: (1) the modification of known cost data, (2) the use of graphic methods, (3) the use of statistical sampling, (4) the use of index numbers, (5) the use of flat rates or ratios, and (6) the use of formulas.

Short cuts in estimating like short cuts in any mathematical process, subject the estimates to some degree of error. A short cut is useless if the resultant data are so inaccurate as to render the estimate inadequate for managerial use. If the errors inherent in a particular short cut are not of such magnitude as to cause difficulty, however, it may be desirable to employ the short cut in order to conserve time and effort.

MODIFICATION OF KNOWN COST DATA. It is often possible to prepare quick estimates, which are reasonably reliable and require little time, by modifying known cost data. On the basis of past experience and records, current cost estimates for similar parts or products may be made up.

For instance, suppose a new part weighs approximately 10% more than the old and requires some additional machining, which is judged to require about 20% more machine time. The prior cost record is altered as follows:

	Part 328B14 Prior Cost (100 Units)	Quantity Adjustment Factor (Percent)	Part 731D7 Estimated Cost (100 Units)
Materials	$32.70	110	$35.97
Machine labor	17.50	120	21.00
Machine overhead	13.00	120	15.60
Total	$63.20		$72.57

Of course such an estimate assumes that no change has occurred in materials prices, labor wage rates, or overhead cost relationships since part 328B14 was made.

If present unit prices of specified materials used and present rate of pay and overhead cost rate are known, adjustments can be easily made to reflect new conditions. Thus, if the price of material has increased 4%, the wage rate for the

operation has gone up 8%, while the overhead cost rate has advanced from 65 cents per man-hour to 70 cents per man-hour, previous calculations could be adjusted as follows:

	Estimate (Original Prices)	Price Adjustment Factor	Estimate (Present Prices)
Materials	$35.97	104%	$37.41
Machine labor	21.00	108%	22 68
Machine overhead (@65¢)	15.60	@70¢	16 80
Total	$72.57		$76.89

GRAPHIC SHORT CUTS. Graphic methods of estimating costs have many applications, one of the most important being the use of the **learning curve** in estimating production costs, as is illustrated in Figs. 3, 4, and 5.

There are other instances where costs can be estimated by graphic methods in order to save an excessive number of computations. The graphic method is particularly useful in industries manufacturing like items of different sizes, as for example in the manufacture of bolts. This may be illustrated by assuming:

1. A given piece of machinery can make bolts ranging from 6 to 10 inches in length.
2. All operations in manufacturing the different bolts require the same amount of time.
3. The only variation in producing the respective bolts is in the different quantities of materials used.

Knowing the actual cost of manufacturing a 6-inch bolt and a 10-inch bolt, it is possible by using a graphic representation to determine the cost of any intermediate-length bolt by **interpolation**, as illustrated in Fig. 6.

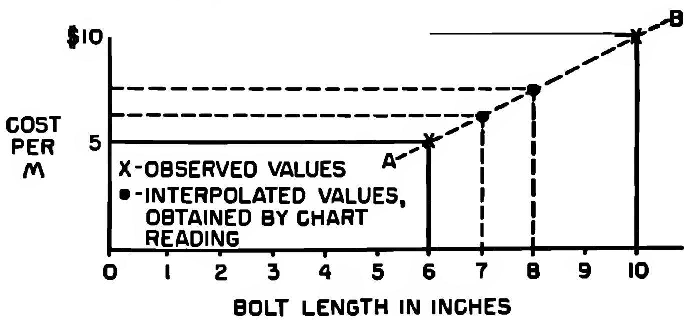


Fig. 6. Estimated cost of bolt manufacture.

STATISTICAL SAMPLING SHORT CUTS. Statistical sampling assumes importance in cost estimation in that various statistical tests may be made to determine what the possible **central tendency** or **scatter** of costs will be. Such a system of cost finding obviously is less time consuming and more economical than cost determination based upon a complete analysis of the record of past events. The more refinement necessary in the cost data, the more intensive or stratified the sampling procedure must be. [For a discussion of statistical sampling, see the Accountants' Handbook (Wixon, ed.).]

INDEX NUMBER SHORT CUTS. Another short cut used in estimating, *though not so common as some of the others, consists of the use of index numbers. If the part or product for which costs are estimated is complex, or if estimates* are to be made by correcting previous actual costs for price level changes, detailed calculations may become time consuming. In many cases it is possible to avoid a large amount of analysis and adjustment of individual wage rates, materials prices, and overhead charges by means of index numbers.

Index numbers are indicators of change from one point or period of time to another. Ordinarily an index number used in cost estimating is a composite of a number of elements of cost. As a composite it is an **average,** and changes of the average depend upon the shifting importance of various elements in the cost, as discussed in this section under Proportionality on Specific Jobs.

One of the simplest forms of index numbers is illustrated by the following example:

Year	Total Payroll	Total Man-Hours	Average Rate per Hr.	Index Number of Wage Rates (1958 = 100)
1958	$1,125,000	450,000	$2.50	100.00
1959	900,000	400,000	2.25	90 00
1960	1,020,000	425,000	2.40	96.00

Use of such an index can be illustrated by assuming that 1,000 units of a given product were made in 1959 and that the cost sheet for the particular lot showed total labor costs of $9,000. If another lot of 1,000 units of the same product is produced in 1960, labor cost can be converted to 1960 wage levels by the following calculation: ($9,000 ÷ 90) × 96 = $9,600.

FLAT RATE OR RATIO SHORT CUTS. In certain cases costs are estimated on the basis of flat rates or ratios. For instance, the cost of goods sold is sometimes estimated as a given percentage of sales price, with the resulting cost figure being useful for rough managerial purposes.

In the case of the building industry, flat rates are frequently used for rough estimates of the cost of construction of a given quality. The cost of construction of housing may be estimated at $15 a square foot, with variations dependent upon changes in quality and shifts that may occur in the balance of various items entering into construction, as are illustrated in the discussion on Proportionality on Specific Jobs in this section.

FORMULA SHORT CUTS. Some industries find the employment of formulas in the estimating of costs to be most useful. Barker (NAA Bulletin, vol. 39) points out that in **truck transportation,** the use of a system of formulas can provide management with good cost information on everything from the transportation of household goods, general freight, and heavy hauling to tank line operations. Barker also emphasizes that:

> These are not historical costs of past operations but are formulas by which the cost of what is going on at the moment can be determined, or by which costs of contemplated work can be accurately estimated.

In Fig. 7, Barker (NAA Bulletin, vol. 39) gives an example of the formula that can be used to estimate direct costs of a job performed or to be performed and to determine the estimated **gross profit margin** and gross profit margin per power unit hour.

Estimating Formula

(For direct costs of a job, performed or to be performed, to determine the estimated gross profit margin as an amount, a percent to sales, and per power unit hour)

1.	Figure total hours of equipment time for the trip (or trips); multiply by rate indicated in Schedule A-1 for equipment combination employed		$ xxxx
2.	Figure total miles (loaded and empty); multiply by rate indicated in Schedule A-1 for equipment combination employed		$ xxxx
3.	Figure total hours of labor time for the trip (or trips); multiply by rate indicated in Schedule A-2 for class of labor employed	$ xxxx	
	Add: Subsistence and layover pay	$ xxxx	$ xxxx
4.	Figure revenue for the trip (or trips); apply the following percentages to determine estimated revenue expenses:		
	B.I., P.D., and cargo insurance (apply in all cases) ..2.10%		
	B.E. tax (where applicable) ..3.00%		
	P.U.C. tax (Intrastate only) ..0 25%		$ xxxx
5.	The sum of these calculations is the total direct cost		$ xxxx
6.	Revenue		$ xxxx
7.	Gross profit margin (line 6 minus line 5)		$ xx
8.	Percent gross profit margin to revenue		...%
9.	Power unit hours		xxx
10.	Gross profit margin per power unit hour		$ xxxx

Schedule A-1

Type of Equipment	Per Hour	Per Mile
Local vans (Bobtails)	$0 8814	$0.0672
Local tractors: semi-trailers	1 5377	0 1158
Tractor: flatbed semi-trailers	1.6427	0.1034
Line haul tractor: semi-trailers	1 0852	0 1165
Tractor: box trailer	2.1223	0.1135

Schedule A-2

Local Hauling	Rate per Hour
Driver and helper: straight time	$5.309
Driver and helper: overtime	7.117
Extra help, per man: straight time	2.584
Extra help, per man: overtime	3 460

Fig. 7. Formula for estimating direct costs.

PROPORTIONALITY ON SPECIFIC JOBS. In the use of short cuts such as index numbers, flat rates, ratios, and formulas, it is important to observe the effect of changes in the proportion of various elements of cost. The resultant effect of such changes may be shown by the following illustration for the cost of a house of 2,000 square feet:

Cost Situation No. 1

	Cost	Percentage
Labor	$ 9,000	30.0
Materials	6,000	20.0
Overhead	4,000	13.4
Subcontracts	11,000	36 6
Total estimated cost	$30,000	100.0
Cost per square foot	$15.00	

Cost Situation No. 2
(More subcontract work)

	Cost	Percentage
Labor	$ 7,000	21.9
Materials	5,000	15.6
Overhead	4,000	12.5
Subcontracts	16,000	50.0
Total estimated cost	$32,000	100.0
Cost per square foot	$16.00	

In this situation it is assumed that the rates of cost for each of the various elements of labor, materials, and overhead remain unchanged. As the contractor shifts to more subcontract work, however, the higher the cost per square foot becomes.

Errors in Estimating

TYPES OF ESTIMATING ERRORS. The fact that most estimating calculations represent some compromise of accuracy for the sake of expediency indicates that most estimated costs are subject to a certain amount of error. Obviously the value of a given set of estimated costs depends upon the extent to which errors have been avoided or minimized. Some of the errors to be encountered in estimating are the result of the human element, inadequate analysis, the use of averages, omissions and duplications, or inconsistencies between compilation of data and estimating.

THE HUMAN ELEMENT. The very fact that estimates are made by human beings means that they are subject to whatever errors the particular estimator is subject to. No matter how meticulously the procedure of estimating is established, there is a certain amount of interpretation, intuition, and judgment involved on the part of the estimator. He must be able to supply from his experience, and through the process of logical reasoning, whatever lack of information there may be in the data available to him.

Notable among the **human errors** that creep into estimates are those which result from the oversight of certain elements of cost and those due to failure to make computations correctly. Errors of this nature may be avoided, or at least minimized, by care and caution and by one individual reviewing the work of

another. If this is not feasible, the estimator should review his own work after he has been away from it for a while.

INADEQUATE ANALYSIS. The failure to make an adequate analysis of all relevant facts in any given situation may lead to errors in the estimate. For example, the failure to realize that a given **production schedule** calls for overtime work at overtime premium pay will result in an understatement of cost. Likewise the failure to understand favorable production situations will result in overestimating costs and the loss of desirable and important jobs. Any failure to understand the nature of **products** or the nature of necessary **productive processes** invites errors to enter the estimating process.

USE OF AVERAGES. The large amount of averaging involved in the costing procedure warrants special emphasis when considering errors in estimating. All allocations of indirect costs are based upon averaging of some sort; even direct cost allocations often require averaging with respect to price factors. Every cost sheet in a cost accounting system which calls for more than one unit of product involves some application of the averaging principle.

Averaging arises in part from the necessity for using average figures to reduce a number of different things to a single figure to express a tendency or to simplify a problem. The danger is one of oversimplification by assuming similarities or relationships which do not exist. The base upon which an average is computed should be narrow enough to exclude factors which are basically dissimilar. For this reason a departmental cost rate is more accurate than a blanket rate.

The choice of an **averaging base** is a matter of compromise between accuracy and effort. Judgment and experiment are the only means of making such choice, and the cost-finding or cost-estimating process is therefore always subject to some error from this source.

Although the use of averages may introduce errors into estimating, such errors may be minimized, as indicated by Noltemeyer (NAA Bulletin, vol. 36) when discussing the problems involved in estimating overhead:

> Theoretically, it is desirable to estimate factory overhead dollars as a percentage of direct labor dollars for each department, using departmental percentage figures. However, from a practical standpoint, the competent estimator will soon be able to judge the approximate average percentage to apply to the total labor for different types of products. A visual analysis of the distribution of labor operations by departments should suffice to enable him to estimate the proper average percentage figure to use. This method is not exact, of course, but, inasmuch as an application of the departmental percentages would involve a great amount of detailed figuring, a competent estimate should be adequate. The possibility of error will be constantly diminished as the skill of the estimator increases.

OMISSIONS AND DUPLICATIONS. Cost estimates must omit no relevant factors, and no factor should be counted more than once. Yet errors of omission and duplication often appear in cost estimates.

The danger of omission increases with the increase in complexity of production or construction. It also increases with the degree of variation from the usual type of production or construction. For instance, when making a bid on a large quantity of galvanized bolts, a particular manufacturer's staff failed to include an estimate for galvanizing. The manufacturer was awarded the contract at considerable loss. In another case an electrical contractor overlooked the cost of exhaust fans to be installed in a building as part of his contract. He also received the contract at a loss.

Duplications in estimates often arise in such areas as **overhead and labor distributions.** Such errors in estimate may result, for instance, from the use of a labor rate which includes social security taxes, workmen's compensation insurance, and other fringe benefits, while at the same time such costs could be included in general overhead.

While errors in omission and duplication are not easily avoided, there are some checks which can be applied:

1. No estimate should be submitted without being checked for omissions and duplications, at least to the extent of being reviewed by someone other than the person who made the estimate.
2. If the estimate can be compared with some previous job or similar set of operations, there is reason to expect that the omissions or duplications will be caught.
3. Sometimes it may be advisable to check the detailed estimate by comparing it with some kind of short-cut calculation, to establish a certain amount of reasonableness. Even a comparison with some rough standards of rule-of-thumb guess may have usefulness in deciding whether or not errors of omission or duplication have occurred.

INAPPROPRIATE ARRANGEMENT OF DATA. There may be inconsistencies between the data compiled and the requirements for estimating. The data may be compiled in one way, whereas the requirements of the estimator may call for data in another form. The breaking down of the data into the form required for the estimate may defy accurate rearrangement, and therefore this will result in errors in estimating. Such errors often arise when there is some change in the method of production or construction which in itself entails a new data arrangement. Such inconsistencies also frequently arise when there is a change from one type of production or construction to another.

VARIANCE DUE TO ERRORS OF ESTIMATE. The actual cost performance is usually compared on an over-all basis with the aggregate of the estimated costs. It follows that the greater the errors involved in the estimate, the greater the variance of actual cost from the estimated cost. Such errors are sometimes referred to as **errors of estimate.**

When analyzing the variance between the actual cost and the estimated cost, errors of estimate should be segregated from variances due to other causes. For instance, to the extent that operating efficiency differs from estimated efficiency, there is a variance. In order to measure properly the variations in efficiency, it is necessary to exclude from total variance that portion due to any errors contained in computing the original estimate. This may be illustrated as follows:

Computation of Variance

Actual cost of construction	$62,000
Estimated cost of construction	57,000
Total variance from the estimate	5,000
Errors of estimate	3,000
Variance due to inefficiency	$ 2,000

The Estimating Department

NATURE AND ORGANIZATION. An estimating department is frequently thought of as involving the activities of a group of people in connection with some form of construction organization which obtains its contracts by submitting bids whenever opportunity offers. In such a case the estimating depart-

ment may be considered as a pure estimating department and strictly centralized. In other instances, however, such as in the canning industry, it is more likely that the estimating department is a part of the **accounting organization.** In some industries, such as the chemical industry, there may be an **estimator,** or a group of people whose responsibility is estimating, in practically every operating department. In stressing this point Tallman (NAA Bulletin, vol. 36) points out:

The control divisions of each department, besides keeping the accounts of the department, have groups which regularly estimate the cost implications of proposed changes in plant operations. Similarly, nearly every plant has an estimating group as part of its accounting organization. Many of the departments have planning divisions which use cost estimates as tools in planning the long-range future of the over-all business of the department. Finally, the engineering department of the company has a very large estimating group, which prepares firm cost estimates upon which are based requests for appropriations of money for major plant construction.

From the foregoing it is apparent that the **degree of centralization** of the estimating organization varies from industry to industry and from company to company within an industry. The chief advantage of centralization is that it ensures speed in the preparation of estimates. **Decentralization,** however, offers the following advantages:

1. Each department or division having a hand in preparing the estimate feels obliged to contribute when required.
2. The entire company personnel acts as specialized estimating consultants in giving the latest developments and most pertinent information.

FUNCTIONS. The major functions performed by an estimating department include:

1. Estimating for setting sales prices.
2. Estimating for determining whether or not to engage in certain kinds of business activity.
3. Estimating for setting standards for control purposes.

The **price-setting function** is not a function which depends entirely upon estimates prepared by the estimating department, since modifications may have to be made from time to time to conform with general economic conditions, specific market conditions, and the financial structure of the company doing the selling, together with the speculative factor of what all these conditions may be in the future. (For a discussion of the problems of pricing, see section on Special Cost Analyses.)

PERSONNEL REQUIREMENTS. Regarding the qualifications of the members of the estimating department, Lang–McFarland–Schiff (Cost Accounting) state that:

They must possess on the technical side a thorough knowledge of the engineering basis of the product whose cost is to be estimated. This involves a knowledge of the kinds and quantities of materials required in its manufacture, labor operations, tool costs, and machine requirements. On the accounting side, the estimator must be thoroughly familiar with the official account classifications, with the nature and behavior of the expense accounts, and the bases upon which the overhead costs are apportioned.

The organization of the estimating department may range all the way from a very small and simple organization to a rather large and complex one. In regard to the personnel Matz–Curry–Frank (Cost Accounting) maintain that:

Regardless of departmental affiliation, the estimator should possess a knowledge of cost accounting and some engineering ability. He must also have a thorough knowl-

edge of the plant layout, the production methods, and the machinery and tools available and required for the various jobs.

Accounting Knowledge. The estimator requires a knowledge of **cost accounting** so that he may be able to interpret cost analysis sheets and cost statements and make proper deductions therefrom in using these records for estimating costs. He requires a knowledge of **general accounting** to enable him to determine properly the overhead charges which prevail at the time of making estimates. He must understand why overhead rates fluctuate and must also understand the relation of overhead rates to general production and to increases of cost of materials and labor. He must be able to assign relative values to these items and determine what amounts are to be used in his cost estimates.

Engineering Ability. The estimator must have some engineering ability because he is constantly confronted with problems of estimating on parts or products which have not been manufactured previously and on which regular engineering time cannot be spent. As a general rule, however, this refers to simple engineering problems and not to those involving stresses and strains, electrical characteristics, chemical analysis, etc. The estimator's engineering ability should enable him to determine whether or not future engineering work is necessary before proceeding with the cost estimate.

Production Knowledge. The estimator must have a thorough knowledge of the **plant layout, production methods,** and **machinery** and **tools** required and available. If a new product comes in for estimating, he should know in all ordinary cases where the product is to be made, what processes are necessary for its manufacture, what labor rates will be used, kinds of materials which will be worked upon, and what machines and tools are needed and available for its production. He should have a knowledge of tools and equipment on hand so as to guard against estimating on new tools where old ones may be usable. He should know the production capacity of the plant so that he can determine whether or not the time allowed for production is sufficient. He should also keep in touch with the current production so as to determine if capacity is available in case the order is received, and whether it may be necessary to install new equipment or to work overtime.

Economic Information. If the estimator participates to any extent in setting prices, he must keep in touch with the general economic conditions so as to determine in his own mind whether or not **commodity prices** may be expected to rise or fall, whether or not the **market** will absorb a large or small quantity, and whether greater sales effort and expenses are necessary for the distribution of the item to be priced. In addition he must determine in advance how much profit can be expected over certain periods of time from the sale of the item at either low, medium, or high prices.

If the estimating department is composed of several persons, it may, of course, be desirable to employ subordinates who are specialists in various lines of production or specialists in the functions previously mentioned, such as a person familiar with general and cost accounting, an engineer and draftsman, and a production man. A subordinate staff may be required for clerical, stenographic, and filing work.

PREPARATION OF ESTIMATES. The methods used in the preparation of estimates vary from industry to industry and from company to company within

an industry. However, as pointed out by H. E. Howell (The CPA Handbook, Kane, ed.):

If what purports to be an estimate (unless for a repetitive item for which accurate quantitative data are known) is not prepared from bills of materials, processes, and labor operation schedules and forward prices drawn up from specifications and blueprints, such an "estimate" is useless except to prove whether an estimator "guesses right or wrong."

Data Required for Estimating. Although the method used may vary from situation to situation, the preparation of a cost estimate, as indicated by Lang–McFarland–Schiff (Cost Accounting), should be based on:

1. Complete drawings and specifications of the product.
2. The quantity to be manufactured.
3. Raw materials and purchased parts required and their expected costs.
4. List of labor and machine operations to be performed, operation times, and rates.
5. Overhead applicable to product.
6. Complete data concerning equipment available, its capacity, and its operating costs.

Such a variety of methods is used in preparing estimates that it would be impossible to describe them all. As Blocker and Weltmer (Cost Accounting) put it, "Even the simplest forms of mental cost calculations are, in the strict sense of the phrase, cost estimates." They go on to point out that even "the garage mechanic who compiles the average cost of grinding the valves on various types of cars has an estimate cost plan which, though simple, may be adequate for his purposes."

Complex Estimate Procedure. Specific plans for preparing the estimate become increasingly necessary as a particular business enterprise becomes more complex. The following procedure is indicative of how some of the more complex situations are handled.

The sales department receives the customers' inquiries and supplies the necessary drawings and specifications. After consulting the estimating department, they issue a request to the proper departments for an estimate. The engineering department approves the design of the product and specifies the type and usage of material. The tool department outlines the process, and lists and prices the tools and equipment. The standards department approves the outlined process and estimates the direct labor cost. The purchasing department prices the materials and secures subquotations on individual items.

The estimating department coordinates the contributions of the other departments to ensure the accomplishment of a sound estimate and fulfilment of the customer's and sales department's requests. It checks the accuracy and reasonableness of the estimated materials, labor, and tools. It applies the overhead and summarizes the factory cost. It is also the responsibility of the estimating department to analyze and justify all the details of the estimate. It must prepare, when necessary, **breakdowns** and **special studies** to aid the sales department in determining, explaining, and selling the quotation.

FOLLOW-UP OF ESTIMATES. Matz–Curry–Frank (Cost Accounting) maintain that fundamentally the usefulness of an estimated cost system depends upon the comparison of actual costs with estimated costs. An estimate, therefore,

is not complete unless **actual costs** are ascertained and compared with the **estimated costs.** Variances between estimated and actual costs must be followed up and analyzed to determine if:

1. Actual costs are at fault.
2. Estimating data need correction.

Estimating Cost Systems

DEFINITION. An estimating cost system is one in which **estimated unit costs** for materials, labor, and manufacturing overhead are used as a basis for:

1. Recording costs in the books of account.
2. Comparing such costs with actual costs
3. Analyzing variations between estimated and actual costs.

As indicated by Lang–McFarland–Schiff (Cost Accounting), "Such use of cost estimates is essentially a short-cut method designed to obtain some of the benefits of cost accounting with a minimum of expense for record keeping."

ADVANTAGES OF ESTIMATING COST SYSTEMS. Matz–Curry–Frank (Cost Accounting) point out that even though an estimating cost system is not a complete cost system, it nevertheless provides management with:

1. A unit cost estimated in advance that permits periodic comparison and revision if desirable.
2. An opportunity to compare actual results with predetermined figures.
3. A cost of sales figure without the use of expensive perpetual inventory procedures.

In addition to providing management with useful information at a relatively low cost, estimating systems are often used as stepping stones to more complete cost systems, such as the **standard cost** type. In this respect Blocker and Weltmer (Cost Accounting) state:

> A final advantage that can be attributed to the use of estimate costs is that it frequently makes apparent to management the need for a more scientific form of cost control and may be the forerunner of standard costs

DISADVANTAGES OF ESTIMATING SYSTEMS. Costs determined by the use of an estimating system are probably never quite correct. Blocker and Weltmer (Cost Accounting) put it this way:

> The accuracy with which the estimates can be compiled will determine the effectiveness of the system. If, at the end of the period, variances indicate that the estimates are very far below or above the actual production costs, the manager will have been using a tool to guide him in his policies that is so inaccurate as to be useless and even of negative value.

Under stable conditions and the production of standard products which permit accurate calculations of estimated costs, according to Vance (Theory and Technique of Cost Accounting), they provide satisfactory results. However, he goes on to point out that, "They are limited in that they do not permit detailed analysis of variances between actual and estimated costs, since they do not include detailed actual cost records."

Neuner (Cost Accounting) uses both a positive and negative approach in discussing this disadvantage as follows:

It is true that the cost figures obtained under an estimated cost system are not so accurate or so reliable as those obtained under the historical job order cost method. Estimated costs represent a practical method adapted to peculiar business conditions, i.e., advance sale of goods not yet manufactured. But it should also be remembered that not even historical job order costs are absolutely accurate. And the disadvantage of a slight inaccuracy in costs may be greatly outweighted by the advantage of a smaller clerical expense in cost keeping.

ACCOUNTING PROCEDURES UNDER ESTIMATING SYSTEMS. Vance (Theory and Technique of Cost Accounting) summarizes in Fig. 8 the basic procedure involved in estimating systems.

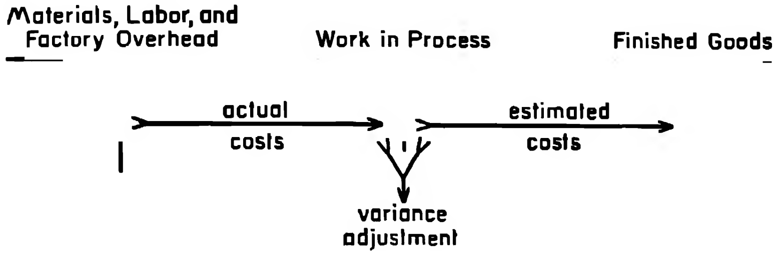


Fig. 8. Basic flow of accounting data in estimating systems.

The steps involved in the operation of an estimating system are listed by Vance (Theory and Technique of Cost Accounting) as follows:

1. Prepare cost cards for each product, showing its estimated unit cost.
2. Charge Work in Process with actual costs incurred, or alternatively, in the case of overhead, cost applied for a period.
3. Credit Work in Process with the cost of product turned out, computed by multiplying the units by the estimated unit cost as shown on the cost card
4. Dispose of variances between actual and estimated costs

Blocker and Weltmer (Cost Accounting) indicate that many different methods of **accounting for estimated costs** are in use. From the many methods they select the following as being the most logical and practical in application:

1. A complete system of job order cost accounting, with estimate costs carried in production orders and accounting records for comparative and statistical purposes only.
2. Use of separate Work-in-Process accounts for each element of cost for the purpose of comparing estimated and actual costs at the end of each accounting period.
3. Use of a separate Work-in-Process account for each production department for the purpose of comparing estimated and actual costs at the end of each accounting period.

ESTIMATED COSTS IN JOB ORDER SYSTEMS. A number of manufacturing companies using job order methods consider it advantageous to set up a record of the estimated materials, labor, and manufacturing overhead costs on each job before starting work on it. They then make a comparison between the estimated and actual costs as the work progresses.

Blocker and Weltmer (Cost Accounting) describe the procedure used by a large paper manufacturing concern, which specializes as a paper converter in coating and finishing paper stock for labels and wrappers, as follows:

> The cost department is requested to prepare an estimate of the cost of each job before a price is quoted to a customer. Past experience, cost sheets of similar jobs, and a forecast of materials, labor, and overhead costs are the basis for the cost estimate for the job in prospect. When the specifications and the job requirements are recorded on a production order to accompany the work through the plant, the estimated costs are recorded on the production order so that a comparison can be made between the estimated and the actual costs as each stage of the work is completed. Cost variances are indicated for materials, labor, and overhead; hence the degree of accuracy with which the estimates were made for pricing purposes is apparent.

A variation of this procedure is to record the total estimates of materials, labor, and overhead costs in **Materials-in-Process, Labor-in-Process,** and **Overhead-in-Process** accounts along with the actual costs.

SEPARATE WORK-IN-PROCESS ACCOUNTS FOR EACH ELEMENT OF COST. Matz–Curry–Frank (Cost Accounting) indicate that, "An estimated cost system that permits comparison of actual costs segregated by cost elements with estimated costs similarly classified is most common."

The accounting procedure underlying this method is outlined by Blocker and Weltmer (Cost Accounting) as follows:

1. The unit costs of each element of the various products to be manufactured during the period are estimated at the beginning of the period.
2. During the accounting period, the cost estimates are used as a basis for costing goods completed; Materials in Process, Labor in Process, Overhead in Process are credited, and Finished Goods is debited for the estimated cost of products completed.
3. When products are sold during the accounting period, Cost of Goods Sold is debited and the Finished Goods account is credited for the estimated cost of goods sold.
4. During the accounting period, the actual cost of materials is recorded in the Materials Control account; the actual cost of labor is charged to the Payroll Control account; and the actual indirect costs are accumulated in the Overhead Control account.
5. At the end of the accounting period, the actual cost of direct materials consumed in production, according to materials requisitions, is credited to Materials Control and debited to Materials in Process; the actual cost of direct labor is credited to the Payroll Control account and debited to Labor in Process; and the actual amount of overhead, including indirect materials and labor, is credited to the Overhead Control account and debited to Overhead in Process.
6. As a part of the process of closing the books, it is necessary to evaluate the inventory of work in process at estimated cost and to transfer the inventory value to a Work-in-Process Inventory account.
7. The balances remaining in the Work-in-Process accounts represent the variances between actual and estimated costs. The balances are transferred to Materials, Labor, and Overhead Variance accounts.
8. Variances are disposed of by correcting Work-in-Process Inventory, Finished Goods Inventory, and Cost of Goods Sold for the amount of the error in the cost estimates so that cost records are corrected to actual costs.
9. At the beginning of the next accounting period, the cost estimates of materials, labor, and overhead are revised in accordance with errors localized in the variance accounts of the preceding period, due consideration being given to forecasted changes in costs for the ensuing period.

Blocker and Weltmer illustrate in Fig. 9 the flow of accounting data when separate Work-in-Process accounts are used for each element of cost.

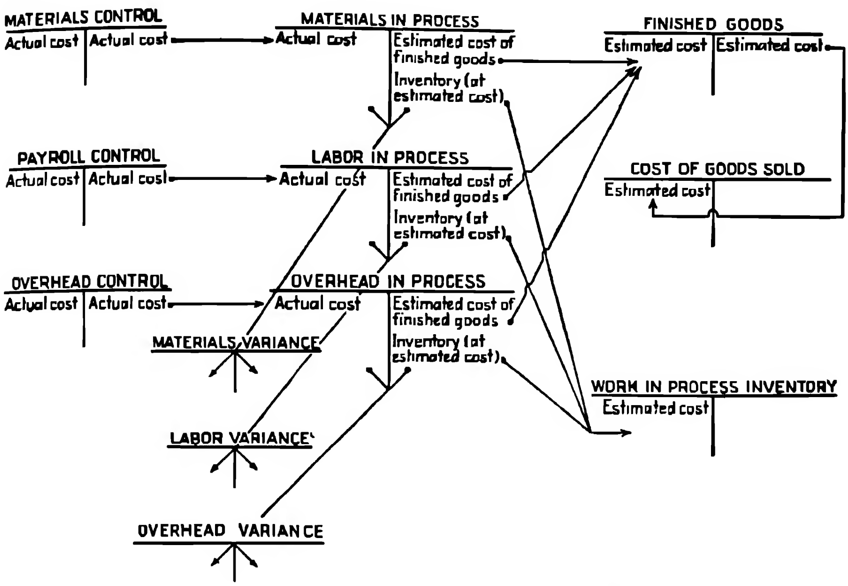


Fig. 9. Flow chart showing separate account for each element of cost.

SEPARATE WORK-IN-PROCESS ACCOUNTS FOR EACH PRODUCTION DEPARTMENT. A variation of the preceding procedure outlined is used when separate Work-in-Process accounts are used for each production department or operation. The general procedure involved in a system of this nature is outlined by Blocker and Weltmer (Cost Accounting) as follows:

1. Estimates of materials cost, labor cost, and overhead are made for each product for each production department.
2. An account is used for each production department as a medium for costing work in process.
3. The work in process for each department is charged for the total actual cost of materials, labor, and overhead costs applicable to production for the period and is credited for the estimated cost of goods completed, which is transferred to Finished Goods.
4. A physical inventory of work in process in each department is taken at estimated costs and is either transferred to a Work-in-Process Inventory account or is used as the opening balance of inventory in the department account at the beginning of the next accounting period.
5. The balance remaining in each department account is the variance between estimated and actual costs of the department. The variance is transferred to a variance account for the department.
6. The variance for each department is prorated over the inventory of work in process for the department, Finished Goods and Cost of Goods Sold; treated as a deferred item; or closed to Profit and Loss or to Surplus.
7. The estimates of materials cost, labor cost, and overhead for each department are revised for use during the next accounting period.

Blocker and Weltmer illustrate in Fig. 10 the flow of accounting data when separate Work-in-Process accounts are used for each production department.

Matz–Curry–Frank (Cost Accounting), while indicating that this system may be an improvement over that in which a separate Work-in-Process account is used for each element of cost, maintain that the greater refinement of the system leads to greater clerical cost and difficulties. Too much refinement, they emphasize, may result in a cost system whose detailed computations and many prorations are far removed from any previous notions of simplicity and low cost.

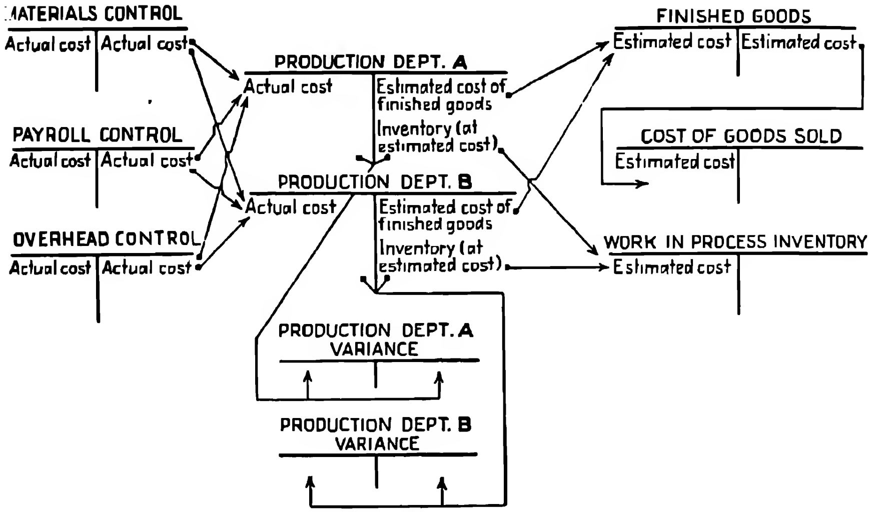


Fig. 10. Flow chart showing separate account for each production department.

VARIANCE OF ACTUAL FROM ESTIMATED COSTS. As indicated by Blocker and Weltmer (Cost Accounting), variances present in the Work-in-Process account or accounts may be the result of any of or all the following:

1. Estimates which may have been incorrectly computed.
2. Seasonal conditions of actual costs and/or production.
3. Abnormal conditions which are beyond the control of management.

DISPOSITION OF VARIANCES UNDER ESTIMATING SYSTEMS. Variances between actual and estimated cost may be disposed of by:

1. Closing them to Cost of Goods Sold or to Profit and Loss.
2. Spreading them over the goods completed during the period.
3. Spreading them over the cost or the quantity of effective production, i.e., over the work in process, finished goods, and cost of goods sold.
4. Transferring them to a deferred account. often called a Variance Reserve.

Although strictly accurate adjustments of variances are possible in estimated cost systems, Vance (Theory and Technique of Cost Accounting) indicates that the more popular procedure is to close the variances intact to Cost of Goods Sold or to Profit and Loss. Cost of Goods Sold is commonly used because the variances represent manufacturing costs, and the bulk of manufacturing costs for any considerable period are in the Cost of Goods Sold account.

Closely related to the procedure of closing the variances to Cost of Goods Sold is the process of spreading them over the **goods completed** during the period. This affects Finished Goods as well as Cost of Goods Sold.

With regard to spreading the variances over the **effective production,** Vance (Theory and Technique of Cost Accounting) states:

> The most perfect disposition of variances in an estimated cost system, as in the case of overhead variance in a job order system, is to recalculate the unit costs of products in which the difference between the actual and the precomputed costs arose, and to adjust inventory accounts as well as cost of goods sold account.

According to Neuner (Cost Accounting) this procedure has the effect of correcting the estimates and adjusting the inventories which will appear on the balance sheet and which will be used to determine the cost of goods sold on the profit and loss statement. Spreading of the variances may be effected on the basis of number of units, effective or equivalent, or on the basis of cost values.

Regarding the use of a **deferred account,** Lang–McFarland–Schiff (Cost Accounting) point out:

> Variances may be deferred by setting up a Variance Reserve on the assumption that it will eventually be offset by an opposite variance Variances in cost due to different numbers of working days in a month or seasonal fluctuations in activity may justify use of this method. However, it is generally used only for monthly or quarterly closings, one of the other methods being used at the year's end.

SECTION 15

SETTING STANDARD COSTS

CONTENTS

CONTENTS (*Continued*)

SECTION 15

SETTING STANDARD COSTS

Nature and Advantages of Standard Costs

NATURE OF STANDARD COSTS. The nature of standard costs may be disclosed in part by a definition of that term, but no single definition can encompass all the different meanings that cost accounting writers attach to the words **standard costs.** Better understanding of the **types of standards** is achieved, therefore, from an examination of underlying assumptions as to **price level, performance level,** and **output level.** The relationships between budgets and standard costs also must be examined if the nature of standards is to be understood.

Standard Distribution Costs. Three sections of this Handbook (Setting Standard Costs, Operation of Standard Costs, and Analysis and Control of Standard Cost Variances) deal with standard costs in general but emphasize their use in **manufacturing operations.** The **distribution function** of many firms is equal in importance to the production function, and in some firms it is more important. To a large extent the discussion in these sections is applicable to the distribution cost area. Some significant differences, however, are discussed in The Accountants' Handbook (Wixon, ed.), which points out that distribution standards are more difficult to establish than manufacturing standards and apparently are less frequently incorporated into the formal accounting records.

DEFINITIONS. The terms **standards, cost standards, standard costs,** and **estimated costs** are sometimes used interchangeably, but generally the distinctions discussed in subsequent paragraphs are made by cost accounting authorities.

Standards. Standards are bases for measurement or comparison. Standards are established by authority, custom, or general consent as a model or example of that which is proper and adequate for a given purpose (Webster's New International Dictionary).

Cost Standards. Cost standards are scientifically predetermined costs of products, components of products, processes, or operations. Cost standards are not recorded in the books of account but are used as statistical bases for the evaluation of actual performance.

Standard Costs. Standard costs are scientifically predetermined costs of materials, labor, and overhead chargeable to a product or service. The process of **setting standard costs** should include:

1. A careful selection of materials.
2. Time and motion studies of operations.
3. An engineering study of equipment and other manufacturing facilities.

Standard costs represent a carefully planned method of making a product or rendering a service. Standard costs are usually entered in the accounts to facili-

tate the evaluation of actual performance. Standard costs and cost standards serve substantially the same purposes from the management point of view. From the accounting point of view, standard costs in the accounts facilitate bookkeeping and cost reporting and reduce the expenses thereof.

Estimated Costs. Estimated costs are costs of products, components, processes, or operations compiled before production takes place. Estimated costs usually are compiled by methods which are not so scientific as those used in standard costs. Estimated costs may or may not be entered in the accounts. (For a detailed discussion, see section on Estimated Costs.)

TYPES OF STANDARD COSTS. Although there is general agreement that standard costs are scientifically predetermined costs, there are many different types of standard costs presented or advocated by prominent cost accounting writers. Standard costs sometimes are divided into two groups: (1) current standards, and (2) basic standards.

Current standards, in general, reflect what performance should be in the period for which the standard is to be used. As will be seen in the pages which follow, there are a number of factors involved, and these are not always combined in the same way by different individuals who write or speak of current standards.

Basic standards are described by Vance (Theory and Technique of Cost Accounting) as "standards that are not changed from year to year unless physical features of the process change. The standard cost is not changed as prices and labor rates change. The object in maintaining the standard at its original figure is to permit calculation of variances that show trends." Basic standards are known by a number of different names, including **bogey** standards, **measuring stick** standards, **measurement** standards, **fixed** standards, and **static** standards.

The terms **ideal, perfection,** and **normal** standards are also used at times. Unfortunately not all writers define the terms in the same way. Involved in the definitions of the various types of standards are assumptions as to factors on which the standards should be based, such as:

1. The price level.
2. The performance level.
3. The production level.

EFFECT OF PRICE LEVEL ASSUMPTIONS. The terms **ideal, normal, current,** and **basic** are used to describe standard costs based upon various concepts as to the price level which should be used as the "standard."

Ideal Standards. With respect to price levels, an ideal standard is one which is set on the assumption of the most favorable prices of materials, labor, and overhead items. Once set, they are rarely changed.

Normal Standards. Normal price level standards utilize prices which are expected to characterize the average over an entire business cycle. Thus they are not revised until the cycle has run its full course.

Current Standards. Current price level standards are set on the basis of prices which are expected to obtain for the ensuing accounting period. These standards are revised during an accounting period in response to significant changes in prices.

Basic Standards. The price level assumed when basic standards are set is usually that expected to be in effect during the first year following the establishment of the standards. Such standards are not revised in response to later changes

in prices, and thus they represent a **fixed base** analogous to the base upon which a price index number is computed.

EFFECT OF PERFORMANCE LEVEL ASSUMPTIONS. Implicit in the establishment of standard costs is a concept of an acceptable level of performance. This concept may vary from the ideal down to the average of past performance. The performance level assumption is frequently called the "tightness" of the standard. NAA Research Series No. 11 (NAA Bulletin, vol. 29) distinguishes three types of performance standards: the **theoretical standard,** the **attainable good performance standard,** and the **average past performance standard.** A fourth type, the **normal performance standard,** is sometimes also encountered.

Theoretical Performance Standard. The theoretical performance standard is also called the **ideal,** or **perfection,** standard. According to the NAA Research Series No. 11, such costs represent the best performance possible with the equipment in the plant. The standards may include **allowances** for rest periods and personal needs of operators but should not include any allowances for waste, spoilage, or lost time. The standards are set as goals toward which to work to improve efficiency. It is not expected that such standards will be attained in actual operations.

Attainable Good Performance Standard. The attainable good performance standard "does not eliminate all waste, spoilage, lost time, etc., but includes these elements to the extent that management considers them impractical of elimination during the time the standard is to be in effect" (NAA Research Series No. 11, NAA Bulletin, vol. 29). This standard can be met or surpassed by actual performance but only if high efficiency is attained.

Average Past Performance Standard. The average of past performance may be selected as the standard for future performance. The same NAA research study (NAA Research Series No. 11) points out that methods used in the past may be subject to improvement and that it may be possible to eliminate some of the wastes and losses experienced in the past. Also, "since jobs on which performance is poor are likely to be more numerous and more extreme than are jobs on which performance is exceptionally good, such a standard is usually considerably looser than are standards of the preceding types."

Normal Performance Standard. As in the case of normal price level standards, a normal performance standard is one set on the basis of performance which is expected to characterize the average over a number of future periods. Thus it could be "tighter" than a standard based on the current concept of attainable good performance, or it could be as "loose" as a standard based on average past performance. Often it will be between the two extremes.

EFFECT OF OUTPUT LEVEL ASSUMPTIONS. Four types of standards may be distinguished on the basis of the underlying concept of level of output. The concept may be one of a theoretical level of output, a practical level, a normal level, or an expected level.

Theoretical Standard. The theoretical capacity of a plant may be used as a basis for the setting of standards. Such standards could be attained for short periods under the most favorable circumstances but are almost impossible of attainment over longer periods.

Practical Standard. A standard based on the "practical" output level is closely akin to an attainable good performance standard. It represents the level of out-

put attainable by a plant operating efficiently as to product design and methods of manufacture under current conditions. Such a standard includes allowances for inefficiencies and wastes considered to be unavoidable under existing conditions. Therefore operation of a plant at a level less than "practical" indicates the presence of avoidable inefficiency or the failure of the sales department to secure sufficient sales orders to require utilization of available capacity.

Normal Standard. The normal level of output of a plant is an average of expected seasonal and cyclical high and low outputs. Neuner (Cost Accounting) emphasizes that many of the variations from a normal output level standard are beyond the control of an individual firm and are therefore of little significance in controlling cost variations; however, they do serve to isolate the effects of the business cycle on costs.

Expected Standard. The expected sales volume for the forthcoming period, adjusted for desired changes in inventory position, determines the expected output of a plant for the forthcoming period. This output level may be used in setting the standard costs. Variations from such standards may merely indicate operation at a level of output other than that expected, or they may indicate wastes and losses.

INTERRELATIONSHIPS AMONG ASSUMPTIONS. Types of standard costs described by prominent writers generally represent some intermingling of the price level, the performance level, and the output level assumptions distinguished in the preceding paragraphs. Moreover, the same type-name may be used by two or more authors with two or more meanings. For example, a **current standard** to Schlatter and Schlatter (Cost Accounting) is based on attainable good performance, practical capacity, and current price levels, whereas a current standard to Neuner (Cost Accounting) is based apparently on expected actual performance, expected output, and current price levels. In addition, Gillespie (Accounting Procedure for Standard Costs) presents a detailed classification of materials, labor, and burden standards, all under the heading of "current" standards.

Types of standards presented by various authors also may involve an intermingling of assumptions in the sense that **materials, labor, and burden standards** may be on different bases. Thus, Matz–Curry–Frank (Cost Accounting) state: "A normal standard is applicable chiefly to the problem of overhead absorption because of the division of overhead into fixed and variable elements. Materials and labor standards are generally set upon the basis of expected performance."

ECONOMIC STANDARD COSTS. This is a term used by Vance (Theory and Technique of Cost Accounting) to describe a type of cost "set by deducting a desired profit margin from the selling price of the product." It is therefore a measure of profit achievement and, unlike other standard costs, is not built up by determining the proper amount for each element of cost.

RELATIONSHIP BETWEEN BUDGETS AND STANDARD COSTS. Both budgets and standard costs represent attempts to determine costs in advance.

Points of Similarity. According to Henrici (Standard Costs for Manufacturing) in addition to the relationship mentioned before, both budgets and standard costs "consider departmental expenses according to accounts. Both assume that costs are controllable along fixed lines of supervision and responsibility. Both re-

quire the issuance of periodic comparative cost reports. Both require the measurement of costs as related to some other variable, such as pieces, standard hours, etc."

Points of Difference. Henrici lists four differences between budgets and standard costs:

1. Budgets are statements of expected cost; standards show what costs could be if desirable performance was attained.
2. Budgets emphasize cost levels which should not be exceeded; standards emphasize the levels to which costs should be reduced.
3. Budgets are customarily set for all departments in the company, from sales to manufacturing; standards are frequently set for manufacturing costs only
4. Any marked variances from standards should be investigated; budget savings need not be investigated.

With the exception of the last point, there is general agreement among writers as to the similarities and differences between standard costs and budgets. Some accountants recommend investigating favorable as well as unfavorable budget variances, particularly where the favorable variance is large.

Use of Standards for Budgeting. Matz–Curry–Frank (Cost Accounting) say, "Standards are almost indispensable to the work of establishing and operating a budget." An NAA research study (NAA Research Series No. 11, NAA Bulletin, vol. 29) points out that standard costs are especially valuable in developing the cost side of the budget "because they provide a reliable and convenient source of data for converting the budgeted production schedule into requirements for raw materials, labor, and services." Further, the use of standard costs rather than actual costs in **budget preparation** saves much analysis and adjustment, particularly when the budget calls for extensive changes in product volume or product mixture over the volume or mixture experienced when actual costs were accumulated. When the "tightness" of the standards differs from that desired in the budget, forecasts of variances may be included in the budget as adjustment items to make the budget a realistic picture of expected operations as well as standard performance.

Heiser (Budgeting—Principles and Practice) demonstrates the relationship between the budgeting and the control functions of standards in commenting that:

> While the forecast budget is based on the purchase of specified quantities of material at standard prices and the use of standard quantities required for specified production, the price and quantity unit standards permit a measurement of performance even though the forecast purchases and production are not achieved. A failure to make the quantities of material purchased conform with the budget is significant for the purposes of financial budgeting, but for the purposes of cost control the essential factor is the meeting of the price standard in the case of the purchases actually made. Similarly, a failure to produce scheduled quantities of products may have a serious effect on the over-all plans, but, again for cost control purposes, it is the amount of material used in the actual production which counts.

GENERAL ADVANTAGES OF STANDARD COSTS.

The advantages of standard costs may be summarized in a phrase: they facilitate the performance of managerial functions. Five **functions of management** in which standard costs may be of assistance are: (1) planning, (2) coordination, (3) organization, (4) motivation, and (5) control.

Planning. The usefulness of standard costs as a control device is frequently stressed, but the process of setting standards also can be of prime assistance to management in the performance of its planning function. Management planning,

according to Heckert and Willson (Business Budgeting and Control) means basing action upon thorough investigation, study, and research. The **setting of standards** requires thorough investigation, study, and research concerning all factors of cost and expense. The benefit of such a study is emphasized by Vance (Theory and Technique of Cost Accounting) who states, "Preparation of standards involves a scrutiny of the operations that often discloses inefficiencies even though no further use of the standard cost is made." In addition the scrutiny of **product lines and methods of manufacture** that are requisite to setting standards forces management to plan for efficient and economical operations.

Coordination. The term "coordination" describes the function of making all elements of the business organization strive toward a common goal and subordinate individual aims to the common good. Bennett (Standard Costs: How They Serve Modern Management) describes standard costs as integrating management, engineering, and accounting thinking. He explains, "Management must determine the volume level to be adopted and the set of circumstances to be assumed. The engineer's job is to set the standards within the framework of management's prescription. The accountant's job is to show how these standards compared with the actual results and why there were differences." In a larger sense, the setting of acceptable standards for all factors of cost involves defining goals and explaining to all concerned their roles in the attainment of the goals.

Organization. Keller (Management Accounting for Profit Control) observes that if standards are to be used effectively as tools for control, they must be established for cost centers according to the concept of **cost responsibility.** If the organization of a plant does not provide for clearly defined lines of responsibility and authority, these weaknesses should be disclosed in the process of establishing a standard cost system.

Motivation. Since the days of Frederick W. Taylor it has been axiomatic that individuals are more inclined to do an acceptable job if they have a clear idea of what constitutes an acceptable job. The setting of standards, particularly attainable good performance standards, may be a considerable motivational aid. Roe (NAA Bulletin, vol. 36) notes that "Men are more willing to be judged against such standards," and that under such standards, ". . . a man is less likely to 'pass-the-buck' for his own deficiencies."

Control. "Control" describes that function of management which has to do with guiding all parts of the organization along paths which the owners or managers have determined should be followed. Henrici (Standard Costs for Manufacturing) emphasizes that the survival of a business depends upon continued sales at a continued profit, that "too frequently" the management cannot control prices, and that therefore its only recourse is to control costs. Costs, Henrici states, cannot be controlled unless they are understood, and the setting of standards is the route to the understanding of costs. Many authors point out that the **primary usefulness of a standard cost system** is to facilitate control through the comparison of actual costs with standard costs; control is achieved by the action of management resulting from the investigation of variances between actual and standard costs. (See section on Analysis and Control of Standard Cost Variances.)

SPECIFIC ADVANTAGES OF STANDARD COSTS. There are many specific advantages of a standard cost system over a historical cost system, in addition to the general advantages discussed in preceding paragraphs. Some of

those frequently mentioned are aid to: (1) inventory costing, (2) product pricing, (3) clerical record keeping and clerical cost reduction, and (4) cost reporting.

Aid to Inventory Costing. An NAA research report (NAA Research Series No. 13, NAA Bulletin, vol. 29) indicates that of 72 companies studied, 68 enter standard costs on their books to some extent, and 63 enter standards for all elements of manufacturing cost. The NAA study shows that approximately three-fourths of the companies carry **raw materials** at standard cost, and that most of the companies carry **finished goods** and **cost of sales** at standard. **Work-in-process** accounts are usually charged for materials, labor, and overhead on a full standard basis. Under the typical accounting system studied by the NAA, the difference between actual costs and standard costs is found in **variance accounts.** The number and types of variance accounts depend upon management's desires for information and the accountant's intended treatment of the account balances. According to the study, the customary **disposition of the variances** is to charge them against the income of the period in which the variance arises and to report inventories at standard in the financial statements. The report (NAA Research Series No. 13) concludes that, "This reasoning seems to require standards which are current and attainable. Changes in external factors such as prices or changes in methods and performance efficiency which are made or accepted by management require revision of standards using in costing."

Aid to Product Pricing. Many firms have little control over the prices they receive for their products or services, yet wherever possible, of course, the attempt is made to obtain prices in excess of cost. Furnishing the cost information is a function of the accounting department. NAA Research Series No. 14 (NAA Bulletin, vol. 30) reports that 62 of 67 companies studied make use of standard costs in product pricing. For companies having standard products produced for stock and listed in catalogs, the NAA report distinguishes four groups in respect to cost figures supplied to pricing executives:

1. Companies which supply pricing executives with standard costs without application of any adjustments to the standards. These companies use current standards brought up to date each time a catalog appears.
2. Companies in which costs supplied to the pricing executives are standard costs adjusted by the ratio of actual cost to standard cost as shown by the variance accounts. These companies use current standards revised annually.
3. Companies which use current market prices for materials, and in a few cases for labor, together with standard costs for other elements of product cost when preparing pricing costs. These companies have materials standards, but use current prices because materials cost is such a large element of their total costs, and their materials costs fluctuate frequently.
4. Companies which adjust their standard costs to reflect actual costs which are anticipated during the period for which prices are to be in effect.

For companies which produce to customers' specifications, the NAA study found that costs supplied to pricing executives represented a compilation of detailed **current standards.** Roe (NAA Bulletin, vol. 36) states that a similar process is used in the steel industry to develop price recommendations for possible new products.

Aid to Clerical Record Keeping and Cost Reduction. In addition to control, most authors mention as an advantage of standard cost systems that their installation tends to reduce clerical labor and expense. Neuner (Cost Accounting) shows how this results: "Materials requisitions, labor time tickets, cost sheets, and

operating instructions can be prepared on standard printed forms for use in costing any such production order, since all production orders for a given product will be identical." These simplifications are, of course, of much greater significance in **job order production** than in **continuous process production.** Under either type of production, **stock ledger keeping** can be greatly simplified under a standard cost system because only quantities need be accounted for in the stock ledger.

Obviously some of the clerical time and expense saved through bookkeeping simplification is offset by time spent in deriving standards and keeping them current. The major saving usually effected through use of standard costs is the result of action taken to correct inefficiencies and wastes disclosed when standards are set and when variances from standards are investigated.

Aid to Cost Reporting. From the management viewpoint, actual costs are not so significant as the variances of actual costs from scientifically predetermined costs. A standard cost accounting system facilitates the timely reporting of such variances inasmuch as many of the variances are disclosed currently through the mechanics of the bookkeeping system.

Direct Materials Standards

PREREQUISITES TO SETTING STANDARD COSTS FOR MATERIALS. Before a standard cost system can be established, both **physical standards** and **price standards** must be set for materials. Physical control over materials, product study, and basic data are prerequisites to the setting of materials standards. (See section on Materials for a general discussion of materials.)

Physical Control over Materials. Establishment of a standard cost system presupposes the existence of adequate physical control over the processes of procuring, storing, issuing, and handling of materials from the time a request to purchase is initiated until the finished goods are shipped to a customer. This control comprehends:

1. Accurate budgeting of materials needs
2. A proper purchasing routine.
3. Supervision of incoming shipments and deliveries by a capable traffic expert
4. Facilities for receiving and storing incoming materials.
5. Control of materials issued from stores by use of properly authorized requisitions.
6. A method for identifying and controlling the location of materials in process
7. Proper storage and shipment of finished goods.

Without systematic and careful handling of all these activities, it is not possible to obtain sufficiently dependable cost reports to justify their collection and summarization, for it is plain that managerial control cannot be exercised over buying and using materials unless the executives responsible have definite and accurate information about what is being done.

Product Study. Before standard costs can be set, definite knowledge concerning the product must be available. For a concern that makes only a narrowly limited line of products subject to little variation, this problem is virtually solved in advance; but for a producer of a wide and perhaps continually changing variety of goods, items to be manufactured during the coming period should be listed, and complete **manufacturing specifications** should be procured. When the plant works largely or wholly upon a product produced to customers' orders and when the same design may seldom be used a second time, it is still possible to

classify the product into general types and to find ways in which the special orders are alike. Many parts and subassemblies used in these special jobs may be standard or interchangeable. However, where diversity is present in a very large measure (as in building construction), the drawings and specifications for each order supply basic data, and therefore new standards must be set for each construction order received.

Basic Data. Successful standard cost methods require standardization of product design, operating policies, production routines, and clerical routines, as well as standardization of costs.

Certain basic data must be compiled before the actual setting of cost standards can be undertaken. Such compilations usually require the services of various technical staffs such as the design engineers, chemists, production engineers, and time and motion study engineers, in addition to those of the accounting department itself.

The **engineering and production departments** should record all pertinent facts with regard to the kind and quality of raw materials and "findings" to be carried in stock; the kind, quality, and quantity of raw materials to be used for specific parts; the method and sequence of processing; part description and quantity requirements in assemblies; assembly labor methods and routines; material specifications or bills of material for final assembly or erection; and erection labor instructions.

PHYSICAL STANDARDS FOR MATERIALS. Physical standards for materials are based upon determinations of kind and quality specifications, quantity specifications, drawings, assembly specifications and bills of materials, and spoilage factors.

Kind and Quality Specifications. Both the quantity used of raw materials and the price paid for them often depend upon the kind and quality of the materials. Therefore specifications should be set for the kind and quality of each raw material or purchased part which is used in the manufacture of a product. Setting kind and quality specifications is ordinarily the task of the **engineering department** or the **product control laboratory**. Quality specifications include required physical or chemical characteristics of the material, or both, as appropriate. Such factors as density, consistency, tensile strength, thickness, moisture content, degree of purity, and allowable content of impurities must be determined in advance. Where alternative kinds and qualities of materials may be used in the product, the most economical alternative must be determined. The most economical may not be the one with the lowest purchase price when consideration is given to such factors as ease of handling, spoilage, and assured supply. **Indirect materials,** or supplies, should be given the same sort of examination in order to disclose present and potential wastes and inefficiencies in their usage and purchase.

Standardization Savings. Even though the process of scientific fact finding may be lengthy and quite expensive, as it is in a large plant making a diversified line of products, **potential economies** discovered from this work alone often return the costs of the program.

A machine tool plant was producing a standard machine which contained approximately 25 miscellaneous shafts in its various assemblies. Some were forged, while others were made from steel shafting which varied from ⅜ to 1 inch in diameter. Machining was intricate with varying diameters to suit ten or more bearing diameters and gear or sprocket hub sizes. Complete redesigning of this machine resulted in

adoption of a single size of shafting, namely, ¾-inch diameter. It was found that old shafts of more than ¾-inch diameter were larger than required for sound engineering practice, and that smaller shafts could be increased in size with no deleterious effect on machine operation. All gear and sprocket hubs were standardized at slightly under ¾-inch bore. All bearings were standardized at the same inside diameter. This standardization made it possible for this concern to use straight, uniform diameter shafts throughout the entire machine. Intricate and costly lathe and grinder operations were replaced by cheap machining of all shafts on centerless grinders. Machine and equipment requirements were materially reduced. Number of kinds and sizes of raw materials needed for production of shafts and bearings was reduced by more than 75 percent and investment in raw materials was reduced accordingly. This illustrates a portion of savings which resulted from redesigning of this machine. Similar standardization and economies were effected throughout. As a result the selling price of machines was reduced by more than 60 percent and the potential market more than trebled.

Raw materials inventories can be materially reduced if the engineering department prepares **standard materials lists** which can be used by designers in development of new parts and products. Additions to such lists should be prohibited unless approved by the chief engineer. Examples of such lists are shown in Fig. 1.

STANDARD RAW MATERIALS

Note: All items listed are carried in stock and purchased in sufficient quantity to obtain mill prices.

ITEM Brass Sheets - 80/20

CLASS OR SYMBOL	DIMENSIONS	UNIT
B1	22 Ga. × 6" × 60"	Lbs.
"	22 Ga × 18" × 60"	"
"	22 Ga × 18" × 72"	"
"	20 Ga × 3' × 72"	"
"	20 Ga × 8' × 60"	"
"	1/8" × 3" × 60"	"
"	1/8" × 4" × 60"	"
"	1/8" × 17" × 60"	"
"	1/8" × 19" × 60"	"

A

STANDARD RAW MATERIALS

Note: All items listed are carried in stock and purchased in sufficient quantity to obtain mill prices.

ITEM Armco Ingot Iron Sheets - Blue Annealed

CLASS OR SYMBOL	DIMENSIONS	WGT. PER SHEET	UNIT
141.4	#10 - 36 × 120	168.7	Lbs
"	-48 × 120	225	"
"	-60 × 120	281 3	"
141.5	#12 - 36 × 120	131 3	"
	-48 × 156	227.5	"
1416	#16 - 36 × 96	60	"
	36 × 120	75	"
	48 × 120	100	"
	60 × 156	162.5	"

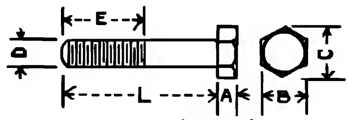
B

Fig. 1. Standard raw materials lists.

An analysis of sizes and kinds of raw materials carried in stock by most concerns usually discloses many items which could readily be eliminated by substituting other materials which are standard. Such elimination should greatly reduce the number of items carried, as well as reduce the amount invested in such raw materials.

Another class of inventory which frequently is found to be unnecessarily large is that of so-called **findings and standard hardware.** A metal manufacturing plant uses such items as machine bolts, capscrews, punched washers, cotter pins,

taper pins, and many other similar items. Clothing and other allied industries use such items as thread, buttons, and binding tape. Most industries have some similar class of inventory materials. If inventories have been built up with little attention to this subject, the engineering department should be required to standardize on a limited number of types and sizes and all little used types and sizes should be eliminated. Standard items should then be tabulated or charted for use of designers, the factory, and accounting department. A chart of this kind is illustrated in Fig. 2.



T = Threads per inch

A	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1			
B	7/16	1/2	5/8	5/8	3/4	13/16	7/8	1	1 1/8	1 1/4			
C	1/2	37/64	21/32	23/32	7/8	15/16	1 1/64	1 5/32	1 19/64	1 7/16			
T	20	18	16	14	13	12	11	10	9	8			
L D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1			E
1/2	S1-1	S1-9											3/8
5/8	S1-2												1/2
3/4	S1-3	S1-10	S1-17	S1-25									9/16
7/8	S1-4	S1-11	S1-18			S1-36							5/8
1	S1-5	S1-12	S1-19	S1-26	S1-30		S1-40						3/4
1 1/4					S1-31	S1-37	S1-41						15/16
1 1/2	S1-6	S1-13	S1-20	S1-27	S1-32	S1-38	S1-42	S1-48					1 1/8
1 3/4		S1-14	S1-21				S1-43						1 5/16
2	S1-7	S1-15	S1-22	S1-28	S1-33	S1-39	S1-44		S1-51				1 1/2
2 1/4								S1-49					1 11/16
2 1/2	S1-8	S1-16	S1-23	S1-29	S1-34		S1-45						1 15/16
2 3/4													2 1/16
3			S1-24		S1-35		S1-46	S1-50	S1-52	S1-53			2 1/4
3 1/4													2 7/16
3 1/2							S1-47						2 5/8
3 3/4													2 13/16
4													3
4 1/4													3
4 1/2													3
4 3/4													3
5													3

STANDARD PARTS

Name U.S.S. Hex Hd. Cap Screws Key Symbol "S1-"

Fig. 2. Standard parts chart.

Figs. 1 and 2 serve the double purpose of aiding in standardization and simplification of inventories and as a guide and specification for the accountant in setting standards for such materials and parts.

Materials Quantity Specifications. In his discussion of materials quantity standards, Bennett (Standard Costs: How They Serve Modern Management) distinguishes three broad classes of industry:

1. Formula-product companies.
2. Nonassembly-product companies.
3. Assembly-product companies.

Materials quantity specifications in **formula-product companies** come from the formulas established by the laboratory, engineering department, manufacturing department, or other responsible office. Bennett points out that the formulas are often secret but that they must be disclosed to the cost accountants, since there is no other way to establish valid standards as to materials usage. He uses a textile mill in illustrating this type.

Bennett defines **nonassembly-product companies** as "those companies which convert a unit of raw material into a finished product without essential change in the material other than the manufacturing processing." He gives a tannery as an example. In such instances, materials quantity specifications must take into account allowances for processing losses. **Shrinkage** and **spoilage** are discussed under Spoilage in this section.

According to Bennett, **assembly-product companies** "are in reality producing many finished products, for each part is in itself a finished unit although not usually a salable product." Most woodworking and metalworking plants can be put in this classification. Standard materials quantities will be determined for each part, generally from the engineering department. Blueprints and other drawings are usually the most accurate source of data. Allowances must be made for waste if the drawings show only the finished dimensions.

Drawings. Raw materials such as sheets, rods, bars, shafting, and standard shapes of steel, brass, copper, nickel, aluminum, and other metals; lumber; cotton, wool, rayon, burlap, and silk fabrics; and other similar standard materials of all kinds can be adequately described on records such as those illustrated in Fig. 1. **Purchased fabricated parts** which are standard in design and can be purchased in the open market, if available in various sizes, can be satisfactorily described on standard parts charts such as that illustrated in Fig. 2.

Most manufacturing concerns, however, produce many fabricated parts from standard raw materials or from special castings and forgings made from dies and patterns of their own design and often assemble parts for their products. All special parts of this nature should be fully illustrated on drawings produced by the engineering department. Such drawings should leave nothing to the imagination of the workmen and should show not only finished dimensions but also a complete description of raw material from which parts are to be made. The engineer who designs a part should know the kind, quality, size, and amount of material which will be used, so that he may bear full responsibility for the most economical use of materials. **Standard raw materials lists** (Fig. 1) should be referred to in determination of raw materials to be used, to avoid addition of new items to inventories if a satisfactory size of material is already carried.

Fig. 7 illustrates the type of drawings described above for the blower subassembly of a heater. Such drawings provide a description of the part, state part number or symbol used for identification, specify kind of material to be used, and

specify all labor operations necessary to convert raw material to finished part or to assemble the parts. The technical blueprints may be supplemented with route sheets as illustrated in Fig. 6. These **route sheets** serve the dual purpose of setting up a permanent record of required processing, together with a record of tools needed; and also, when job number and quantity have been inserted, they are used as **production orders.**

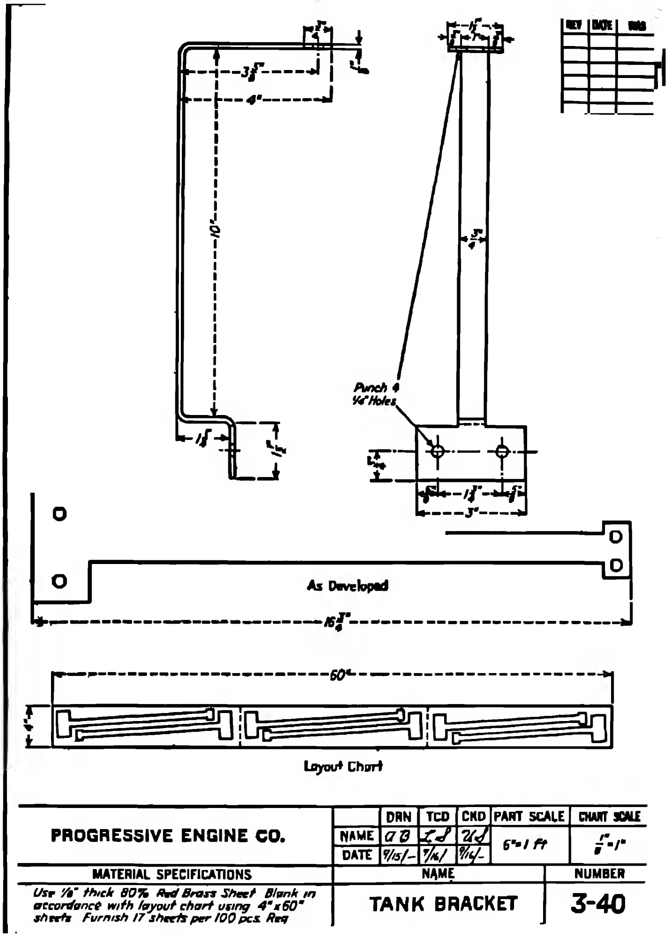


Fig. 3. Drawing and standard layout chart.

If the blanking operation is performed by hand or with tools which allow some latitude in spacing of blanks, it is frequently found desirable to add layout data to drawings which will assure the most economical size of material and a minimum of scrap and trimming waste. Fig. 3 illustrates a layout drawing used in connection with an odd-shaped part which requires special layout instructions. A careful analysis shows that the layout illustrated will result in a clipping loss of

90 pounds per 100 pieces produced, which is 59% of the gross metal required. If 19-inch wide brass were used with blanks staggered and at a slight angle in a vertical position instead of the horizontal position shown in Fig. 3, the clipping loss could be reduced to 58 pounds per 100 pieces produced, which is only 48% of the gross weight required.

An analysis of net cost per 100 blanks using several possible sizes:

Sheet Size	Weight per Sheet	Pieces Produced	Price per Pound	Cost per Blank	Percent Scrap	Scrap Value	Net Cost per Piece
3½ x 60	8.02	3	$0.19	$0.5033	76	$0.1632	$0.3401
4 x 60	·9.17	6	.19	.2907	59	.0720	.2187
6 x 60	13.75	6	.19	.4351	72	.1328	.3023
17 x 60	38.96	25	.24	.3744	60	.0744	.3000
19 x 60	43.55	36	.26	.3146	48	.0464	.2682

A workman or foreman who does not, and need not, know the cost of raw materials would probably select 19-inch stock as most suitable to use, which would result in a cost increase of 23% over the minimum cost obtained when 4-inch stock is used, as suggested in Fig. 3.

Assembly Specifications and Bills of Materials. Assembled products require further engineering data in the form of assembly specifications or bills of materials. The form of such specifications may vary widely to meet the needs of each individual case. Often the finished product is divided into **subassemblies** and **part groups** with separate specifications for each subassembly or group. This method may be used to advantage by firms producing products to customers' orders, if the products produced have many common subassemblies and part groups. The standard cost of each order may be built up from the standard costs of its components.

The **bill of materials** for the parts for a heater is shown in Fig. 4. This bill of materials indicates the usage, part numbers, and description of each component part or subassembly, and whether the part is to be purchased or made. For each manufactured part there must be an additional bill of materials. Fig. 5, the bill for blower assembly "G–700177," shows the parts making up this subassembly, the materials required for each part, the layout of each part, and all other pertinent details.

Each bill of materials for a manufactured part or subassembly is accompanied by complete **drawings** and by an **operation layout** or **route sheet** giving the labor instructions. Fig. 6 shows the operation layout for the blower assembly No. "G–700177," the number of which relates to a drawing (Fig. 7).

Spoilage. Spoilage is a general term often used to include all types of losses which occur in the storage, handling, and processing of materials. Lang–McFarland–Schiff (Cost Accounting) use the term **shrinkage** to describe losses such as the loss of weight in the curing of meats, the term **scrap** to describe a by-product of little or no value, and the term **wastage** to describe the spoilage of materials resulting from inaccurate or careless work.

When loss takes place in **stored materials** (from leakage, evaporation, deterioration, etc.), the price at which materials are charged to the in-process account may be raised enough to cover the amount of the loss, or an expense account may be charged. Lang–McFarland–Schiff cite the example of a plastic

BILL OF MATERIAL
PARTS

Model 940B12

Indent and Usage 1	2	3	4	5	6	Part No.	Description	P - Purchase M - Make
1						940B12	Heater	M
	3					18672	Screw	P
	1					76784	Nut	P
	1					484955	Strip	P
	1					484986	Clamp	P
	1					486802	Ring "O"	P
	2					486803	Washer Exhaust	M
	1					486238	Extension Exhaust	M
	4					487138	Rivet	P
	9					487274	Screw	P
	4					487283	Nut	P
	1					488066	Screw	P
	1					G489619	Heater Comb.	M
		2				7228	Nut	P
		9				18672	Screw	P
		2				76784	Nut	P
		6				79372	Lockwasher	P
		8				79990	Screw	P
		3				91426	Coupling	M
		3				91427	Sleeve	M
		3				170911	Screw	P
		1				473455	Grommet	P
		2				473888	Plug	P
		1				474948	Cable, Knit	M
		2				475005	Lockwasher	P
		1				475067	Gasket, Igniter	P/M
		1				475127	Grommet	P
		1				475318	Elbow	P
		1				G484046	Wheel Assy.	M
			1			471036	Screw	P
			1			475062	Hub, Blower Wheel	M
			1			485283	Washer	M
			1			485345	Wheel Blower	M
		1				G474942	Igniter Assy.	M
			1			7228	Nut	P
			1			91419	Insulator	P
			1			94077	Insulator	P
			1			105161	Washer	P
			1			475151	Insulator	P
			1			G700022	Housing Assy.	M
				1		94076	Wire Connector	M
				1		700021	Housing Igniter	M
	1					G700177	Blower Assy.	M

Fig. 4. Assembly bill of materials.

BILL OF MATERIALS

RAW MATERIALS

G-700177 Blower A and Motor

Gage	Spec	Width, in.	Multiple, in.	Part No.	Name	Layout	Qty.	Wt. per M#	Wt per M Units	Total Wt per M Units	Material Purchased
0.0179	100–52	1 27/32	1 5/8	488932–4	Blade	36 x 96 S	12	17 6	211.2	2.12	0 0179 x 36 x 96
0 0239	100–52	5	4 7/8	488932–5	Plate	36 x 96 S	1	180.3	181		
0.0239	100–52	5 29/32	5 27/32	488932–3	Plate	36 x 96 S	1	249.8	250	4.31	0.0239 x 36 x 96
0.0329	100–05	1 7/16	1/2	484869	Washer	663′ coil	3	2 3	7	7	0 0329 x 1 7/16 x 663′ coil
0.0359	100–52	2 7/16	2 3/8	488932–6	Plate	36 x 96 S	1	62.7	63	63	0.035 x 36 x 96
0.0418	100–51	11 5/8	11 5/8	700180–1	Housing	36 x 96 S	1	1,747.8	1,748	1,748	0.0418 x 36 x 96
0.0598	100–52	12 3/4	1 3/4	489264	Clamp	30 x 96 S	1	463	463		0.0598 x 30 x 96
0.0598	100–52	1 1/8	1 1/8	700383	Washer	36 x 96 S	3	22 77	69		
0.0598	100–52	3 5/8	1 3/32	700147	Bracket	36 x 96 S	3	76 6	230	76 2	0.0598 x 36 x 96
3/4-in. dia.	192–02		0.718	700382	Hub	12′	1	92	92	92	3/4-in. dia x 12′ steel rod

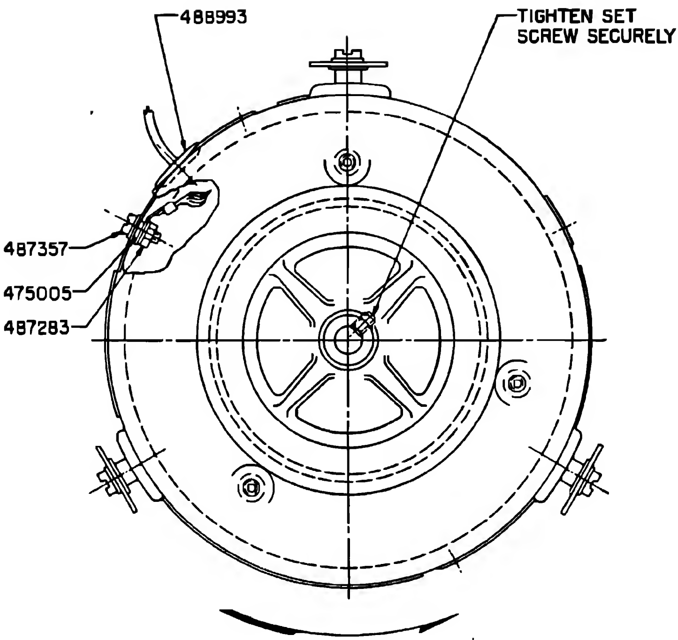
Fig. 5. Subassembly bill of materials.

OPERATION LAYOUT		MODEL NO. 940–B–12	PART NAME Blower Assy Motor (12V)		PART NO. G700177	
PROCESS QUAN. RANGE –			LAST DWG. REV. D	LAST LAYOUT REV. 5/31/___		SH. OF___
REVISIONS EN 3759 Seq 50 rate chgd EN 5068 rev. chgd.	BY RB JB	DATE 2–19–___ 5/31/___				CODE 09
			MATERIAL SPEC.	RAW MATERIAL STOREROOM –		
			WIDTH	MULT.	WT. PER M	

	Seq.	Machine	Gr.	Dept.	Operations	Container Size Spec.	Tools	S.U.Hrs.	Hrs./M
E12.00	10	T934316		821	Assem (1) G700148 brkt, (1) G488932 blower wheel & (1) 489620 motor.				
E53.50	30	T934321		821	Assem (3) each together· 170920 scrw, 700383 wshr, 700145 shock mount & 484869 wshr. Assem mtr & mtg				
					brkt assy/hsg w/above (finger tight) & position grommets. Tighten screws carefully; excessive torque				
					will damage shock mount. Assem 488993 grommet over lead wire & position in hsg.				
E21.20	40			821	Assem (1) G485215 grd wire from motor w/475005 washer & 487357 screw & to housing w/487357 screw,				
					475005 washer & 487283 nut & assem 711235 louvre w/(3) 487274 screws/blower				
E30.00	50			827B	Inspect per Spec T4–230				
	60			821	Move to next asy				

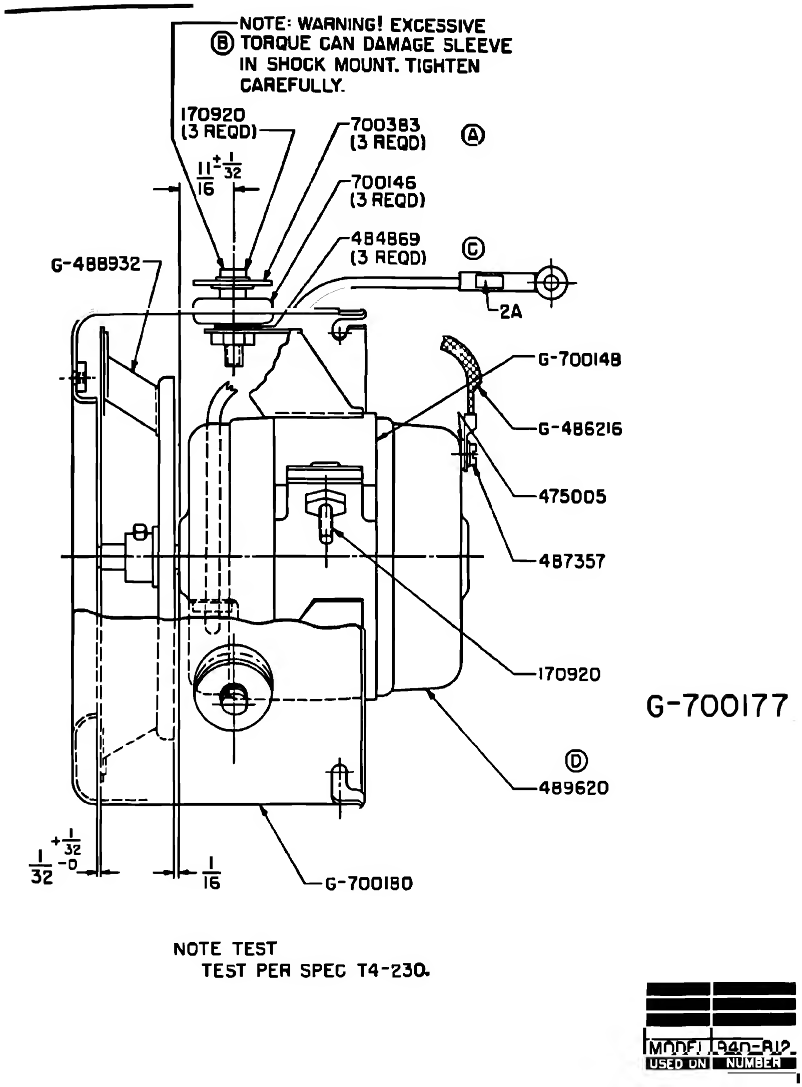
Fig 6 Subassembly operation layout or route sheet

G-700177



1	G-700180	HOUSING ASSY.
3	700383	WASHER
1	G-700148	BRACKET ASSY.-MOTOR MTG.
3	700146	MOUNT-SHOCK
1	489620	MOTOR-(12V.-D.C.)
1	488993	GROMMET
1	G-488932	WHEEL ASSY.-BLOWER
2	487357	SCREW-#8-32 x 3/8 SL. PAN HD. "SEMS"
1	487283	NUT-#8-32 "KEPS"
1	G-486216	LEAD ASSY.-GROUND
[redacted]		WASHER
2	475005	LOCKWASHER. #8 INT.-EXT. TOOTH
4	170920	SCREW-#10-32 x 1 SL. PAN HD. "SEMS"
REQ	NUMBER	NAME

Fig. 7. Subassembly


NOTE: WARNING! EXCESSIVE
(B) TORQUE CAN DAMAGE SLEEVE
IN SHOCK MOUNT. TIGHTEN
CAREFULLY.
170920
(3 REQD)
700383
(3 REQD)
(A)
700146
(3 REQD)
484869
(3 REQD)
(C)
G-488932
2A
G-700148
G-486216
475005
487357
170920
G-700177
(D)
489620
G-700180
NOTE TEST
TEST PER SPEC T4-230.
USED ON
NUMBER

drawing.

molding company which adjusted the purchase price of molding powder from 20 cents a pound to 20.408 cents a pound to compensate for a standard loss of 2 percent of the powder from adherence to containers, spillage, and shrinkage in storage.

When loss takes place while materials are in process, allowance is usually made in the **materials usage standard.** Alternatively this allowance is sometimes set up as a separate item on the standard cost sheet or included in the overhead budget, according to a research study by the NAA (NAA Research Series No. 12, NAA Bulletin, vol. 29).

Wherever the **spoilage allowance** is included, there is general agreement that it should reflect only those losses considered unavoidable under the conditions assumed when setting the standards. These unavoidable losses are called **normal spoilage.** The inclusion of an allowance for normal spoilage in the standards permits **avoidable or abnormal spoilage** to be disclosed through comparison of actual materials usage with the standard.

The concepts of normal and abnormal spoilage are interrelated with the concept of the level of performance to be reflected in the standard. The tighter the performance standard, the smaller the allowance for spoilage. In general, the allowance may be based on past experience, test runs, or engineering or laboratory computations, as is true for the quantity standard.

Not only the standards but also the standard cost accounting are affected by the existence of spoilage. Adequate records of excess material withdrawals, spoiled work, and scrap production must be kept in order that cost variances may be explained and traced to their sources. These records should always name the person responsible in the organization. Various methods have been worked out for giving emphasis to the element of loss involved while preparing the basic record for accounting purposes. For example, when material in excess of the standard quantity allowed is withdrawn, a so-called **excess materials requisition** may be required. This immediately brings to the attention of the foreman the fact that his production center is incurring an unfavorable cost variance and may stimulate him to seek a way to save materials.

When adequate materials usage standards are in effect, control over materials losses, wastes, and spoilages is facilitated because any variance from what has been determined to be a proper figure can be traced to its source. If it is due to faulty equipment, this can be repaired; if due to careless or improper use, pressure can be brought to bear upon the person responsible; or if due to causes over which the company lacks control (such as inability to obtain the proper grade of materials or the lack of skilled workers), the amount of loss from such conditions is at least pointed out in clear fashion.

MATERIALS PRICE STANDARDS. Setting materials price standards calls for the fixing of a standard unit cost for each kind of material or purchased part used; the result is a list or catalog of standard materials prices. Pricing the standard materials specifications depends upon the concept of **price level** to be reflected in the standard.

Kinds of Price Standards. Neuner (Cost Accounting) reports that three types of standards for materials prices or costs are in use:

1. **Current or expected price standards** are the most desirable and effective. When these are used, the purchasing department is supposed to be able to determine in advance, either by long-time commitments or able forecasting, what the expected actual costs are to be during the ensuing accounting period. The accuracy of these price standards is a measure of the efficiency of the purchasing department. One

well-known manufacturer sets these standards in November of each year for the following year. The price standards are not changed, once they are set, until the following year, when they may again be revised. In other words the price standards are used for one entire year before any possible revision. In this firm the purchasing department is held strictly accountable for any variances.

2. **Normal price standards** are more in the line of statistical or average price standards for materials. Usually these are not recorded on the books because the prices cover a period of years, allowing for seasonal variations and long-term trends. Under such conditions inventories of materials, work in process, and finished goods must be based upon the actual, not standard, costs for materials.

3. **Fixed price standards** are usually part of the system which uses basic or bogey standards. Once the prices have been set for materials, these are used as the standards as long as that product is being manufactured. Variances may be indicated on a basis similar to the use of index numbers. Here again inventories of materials, work in process, and finished goods must be based upon the actual cost, not the standard cost, of the materials, since the variances are not indicative of current practices but of a trend over a long period of time.

Setting and Reviewing Price Standards. When current or expected price standards are in use, Neuner (Cost Accounting) says, standard costs for materials may be set as follows:

1. Through prices agreed upon in long-term purchase contracts, usually sufficient to take care of the manufacturing requirements for three to six months in the future.
2. Through use of a statistical forecasting group either within or without the business organization. This group will attempt to forecast probable prices during the coming period.
3. Through the computation of the weighted average of purchase prices on the most recent purchase orders, or
4. Through the use of the median price paid on recent orders.
5. Through the use of arbitrary estimates based upon knowledge and experience in this type of business.

Most of the 72 companies interviewed in an NAA field study (NAA Research Series No. 12, NAA Bulletin, vol. 29) made the report that they base their materials price standards on either a **forecast of the actual price** anticipated during the period that the standards will be in effect or on the **actual price prevailing** at the time the standards are set. The majority of the companies interviewed used current material price standards and reviewed and revised the standards annually, although a significant portion of them reviewed and revised them more frequently. Materials price standards are set by the cost or accounting department in 24 of the 62 companies replying to that question of the NAA survey, by the purchasing department in 12 companies, by the cost and purchasing departments together in 14 companies, and in miscellaneous other departments in 12 companies.

Items Included in Materials Price. Blocker and Weltmer (Cost Accounting) recommend that the standard cost of materials include the price paid to the vendor after deducting both **trade and purchase discounts,** "to which should be added freight charges, cartage, receiving and testing costs, insurance, and storage charges." They also say: "While impractical in many concerns, it seems logical to include the cost of maintaining the purchasing department as a cost of materials. In other words, the price of the material should include all costs incurred up to the time the material is ready to be put into the manufacturing process."

Even if it is not practical to consider all such items in establishing a standard price for materials, serious study must be given to **purchasing, handling, and**

storing procedures to determine whether they are the most effective possible. The studies should result in the determination of the most economical quantities to purchase, the best methods of obtaining delivery at the lowest cost, and the most economical methods of storage and in-plant materials handling.

An example of disclosure of faulty purchasing techniques through use of materials price standards is given by Taylor (NAA Bulletin, vol. 32): One company established a standard of 32 cents per hundred for a rubber grommet. On the first invoice after the standard was in effect it was noted that the price was 49 cents per hundred. Investigation showed that purchase orders had been placed for a quarter's supply of the grommet at a volume sufficient to receive the best price, but faulty shipping instructions had caused deliveries in small quantities at the higher price.

Direct Labor Standards

PREREQUISITES TO SETTING STANDARD COSTS FOR DIRECT LABOR. Standard costs for direct labor are derived from determinations of standard times and standard rates. This process is analogous to the setting of materials standard costs through the determination of standard quantities and standard prices, but the techniques employed differ markedly, since human operators are involved rather than inanimate materials. Whatever techniques are employed, standardized working conditions and certain basic data are prerequisite to the setting of standards.

Standardized Working Conditions. Paralleling the method for setting materials standards, the first step is selection of the best operating method available, in order that it may be used as a basis for the standards. This includes standardization of all surrounding conditions that in any way influence the effectiveness with which the worker performs his task:

1. Consideration of layout, conditions of equipment, the work place, and transportation facilities to standardize these at the best practical level under existing circumstances.
2. Establishment of control over materials in order that the workman may have correct quality and quantity available in the proper place. This requires investigation of purchasing, receiving, and storeskeeping methods, of the plant transportation system, and of placing materials at workbench or machine.
3. Development of a system for planning, routing, and dispatching of work.
4. Provision of all needed instructions for the worker, either in the form of advance training or directions for each specific job.

Since standard costs are thus based upon methods and conditions which it is desired to attain, variations of actual from standard then become indicative of real **variations in efficiency** relative to the standards. Lacking definite specification of what methods should be used and what the surrounding working conditions should be, it is hardly possible to locate the underlying cause for a variation, and further it may also be impossible to determine whether the condition represents a desirable or undesirable state of affairs.

Basic Data. Basic data required prior to setting labor standard costs are similar to the data prerequisite to setting materials standards. Examples of necessary data are: **product specifications** complete as to manufacturing operations involving the use of each class of labor; information as to labor contracts, or company policies, specifying **wage payment plans, job classifications,** and **overtime agreements**; and information as to turnover and availability of personnel by job classes. (See also the general discussion in the section on Labor Costs.)

LABOR TIME STANDARDS. The setting of labor time standards involves two basic questions, according to Henrici (Standard Costs for Manufacturing): (1) What operations are performed? (2) How much time should be spent in each operation per unit of product? The answer to the first question is determined through study of past procedures and the preparation of **process charts** and **standard operation lists.** The answer to the second question may be determined from:

1. Averages of past performance.
2. Time and motion study.
3. Test runs.
4. Advance estimate.
5. Standard motion-time data.

Nature of Time Standards. Since an important purpose of standard cost accounting is **cost control,** direct labor standards should include only the elements that can be controlled by the worker or work center involved. Lawrence (Cost Accounting, revised by Ruswinckel) states:

> If the productive worker's job includes some operation that does not immediately produce a unit of product but is still essential, it is generally considered in computing the standard time. If the worker takes too long on this operation, or does it too often, the excess will show up as excess time. Set-up time is a good example of this situation. However, if the operation, say set-up, is performed by another and the worker is idle, then the worker's pay should be considered as indirect cost as would be time waiting for material, machine repair, and so on. In other words, if the worker cannot be held responsible for the lost time, such time should not be considered a direct labor variance.

The tightness of the labor time standard is, of course, dependent upon the concept of **performance level** on which the standard cost system is based. Generally, when the primary purpose of a cost system is control, the labor time standard is kept quite tight. When costing, or pricing, is considered to be the principal purpose of the cost system, the labor standards tend to be looser, NAA Research Series No. 12 (NAA Bulletin, vol. 29) discloses. According to this same research study, the **responsibility for setting labor time standards,** in companies using scientific methods of setting standards, ordinarily rests with staff specialists attached to the production or engineering department, or with a separate department. If scientific methods are not used, the responsibility for setting time standards may rest with the cost department or with the foremen.

Average of Past Performance. If operations have been performed in the past, a simple way to set time standards is upon averages of past performance. When this is done, any atypical figures should be excluded from past data before averaging. Even with such exclusions, based on judgment, such standards are hardly scientifically predetermined, as standard costs should be. The primary reason for using past averages is to facilitate the establishment of a standard system. After the system is in operation, the standard times are refined by scientific methods discussed in the subsequent paragraphs.

Time and Motion Study. Blocker and Weltmer (Cost Accounting), state: "The determination of efficient standards has attained a higher degree of success in the case of direct labor than in either material or overhead because of time and motion study methods, minute division of labor, and scientific wage schemes in manufacturing plants."

Gillespie (Accounting Procedure for Standard Costs) describes the **time study method** as follows:

> This involves listing the elements, or movements, necessary to perform the operation, timing with stop watch the average workman as he performs the operation, and listing the times. Standard time is evolved by eliminating the wild values shown on the sheet and making allowances for personal factors, tool care, handling, porterage where performed by the operator himself, and defectives not the responsibility of the operator.

Schlatter and Schlatter (Cost Accounting) say that the time and motion study may use the best workman, a good workman, or a gang of workmen, as well as an average workman, as determined by production conditions and the level of performance to be assumed in the standard.

Test Runs. "In some industries such as bakeries," Blocker and Weltmer (Cost Accounting) say, "it has been found that suitable standards for materials and labor operations can be determined without the use of detailed time study techniques through the use of the **test-run procedure.**"

Bennett (Standard Costs: How They Serve Modern Management), however, regards test runs as less reliable even than past-performance averages because conditions in manufacturing are never static and no two similar jobs take the same amount of time in their manufacture. He states:

> Herein lies the weakness in the test-run approach. It will represent a one-shot answer. But the conditions under which it was produced may not have reflected an average situation. There was not the benefit of a calm and objective time study nor the leavening process which would result from the past-performance averages.
>
> If the test run must be used because of special circumstances, the results should be recognized by management as unreliable standards until they can be checked by sounder and more accurate procedures.

Advance Estimate. Another method of determining an **operation time standard** is to estimate it in advance. This method is particularly useful where an operation has not been performed before in exactly the same way, is not to be repeated, and represents an operation of considerable consequence. Thus, construction of a building, ship, or a large special job of any other sort furnishes an occasion where this method of setting standards is useful. Quite often estimates are made first to establish a basis for bidding or quoting a price to the customer; after the order has been obtained, these same estimates may be utilized as standards to facilitate the control of actual operations in order to make sure that the profit anticipated is realized.

Such estimates obviously must be based upon a thorough study of the situation and an assembly of all relevant data obtainable This includes definite knowledge of what is to be done, comparison with past experience in similar operations, and inclusion of allowances for uncertainties. The magnitude of the latter item depends upon the type of standard; that is, whether it is to be actual expected, normal, or ideal although where the same estimates are to serve as a basis for pricing, only the **actual expected standard** can be used for direct materials and labor costs.

In some circumstances it is feasible to develop **empirical formulas,** schedules, tables, or curves from which standards can be set for operations not previously performed. This is essentially the case with a flexible standard, for the formula represents a change in allowed operation time as some dimension of the production process is varied. Development of such a formula proceeds by analysis of the

process to determine what elements are concerned, and then studying the way the operation time varies as the other elements are varied. This variation is expressed in the schedule, curve, or formula from which any value within the range of experience can be derived. The method is a familiar one to time study workers who call it **synthetic time setting.**

Standard Motion-Time Data. There are a number of systems which consist of **predetermined times** associated with basic or **fundamental motions.** Among these systems are the **Work-Factor Plan, Methods-Time Measurement, Basic Motion-Time Plan, Predetermined Time Values,** and **Motion Time Analysis.** According to the Production Handbook (Carson, ed.):

These systems are developed on the basis of two assumptions. The first is that all manual work can be divided into basic units or elements which are universally descriptive and applicable. The second is that an average time in terms of job variables can be associated with each qualitative element. These times also have some degree of universal applicability. Included in the time system is the recognition of work variables which influence the time taken to perform certain elements or motions. Thus the predominant factor of utility in these systems as compared to time study standards data, is the universality of their application to a wide variety of manual operations within a given plant or within a group of plants in general.

Proper **allowances** for fatigue, personal and unavoidable delays, and times required to make every motion used to perform an operation are totaled to obtain the standard time to perform the entire operation.

LABOR RATE STANDARDS. The setting of labor rate standards, according to Henrici (Standard Costs for Manufacturing) involves two basic questions related to those listed under Labor Time Standards in this section: 1. What operations are performed? 2. How much time should be spent in each operation per unit of product? Henrici's questions relating to labor rate standards are:

1. What labor occupations should perform these operations?
2. What rate should be paid to these occupations?

Nature of Labor Rate Standards. The available labor occupations, and the rates therefor, are frequently set by contract. The rates for any firm may also be set by the **prevailing area rates.** For these reasons some writers indicate that rate standards are set only in order that standard labor time may be converted into dollars. On the other hand other writers stress the point that whatever the conditions under which the rates are set, the rate for each occupation should fairly represent the qualifications of the occupation relative to other occupations in the firm. To ensure this, **job classifications** must be carefully established. The classification system should provide for a definite set of **occupation specifications,** covering such factors as level of skill, training, education, experience, and special physical abilities.

It can be seen that such detailed job studies incident to the setting of labor rate standards not only set up a logical basis for **wage rate differentials** but also facilitate effective **manpower utilization** by establishing standards for the occupations themselves. Variations from rate standards, therefore, may indicate improper personnel practices under the control of management. (This is discussed in the section on Analysis and Control of Standard Cost Variances.)

Responsibility for Setting Labor Rate Standards. The responsibility for setting the labor rate standards is often placed on the **cost department,** next most often on the **engineering department** (or a related division such as time

study or standards), and occasionally on the **personnel department** (NAA Research Series No. 12, NAA Bulletin, vol. 29).

EFFECT OF WAGE PAYMENT PLANS ON LABOR RATE STANDARDS. The wage payment plan in use necessarily requires consideration when setting a labor rate standard because different wage plans do not result in the same unit cost for labor. Types of wage payment plans commonly encountered are:

1. Daily or hourly wage plan.
2. Single piece rate plan.
3. Allowed time per unit plan.
4. Multiple piece rate, bonus, and premium plans.
5. Crew or gang rates plan.

Daily or Hourly Wage Plan. Under a daily or hourly wage plan the labor rates are expressed in terms of time, as are the time standards. Therefore the standard labor cost of any operation is the product of the standard time for the operation, multiplied by the rate in effect for workers performing that operation If more than one rate is in effect, reflecting such factors as length of service, versatility, skill level, and experience, a **weighted average hourly rate** is computed by weighting each different hourly rate by the number of men expected to be employed at that rate. By using this weighted average rate as standard, the effect of the different rates established by company policy or union contract upon the actual labor cost for a period will not show up as a variance. Another type of variance may be experienced. Neuner (Cost Accounting) points out that when the volume of production of hourly wage employees may be controlled by the speed of automatic machines, changing the rate of speed of the machine will affect the standard labor cost per unit of production.

Single Piece Rate Plan. Under a single piece rate plan, also called **straight piece rate plan,** or **simple piece rate plan,** the standard labor cost of a unit of product is the piecework price regardless of the number of pieces made in a day by the worker. Any deviation from the standard labor rate per piece causes a price variance to appear. There is no **labor usage** or efficiency standard nor any **usage variance** for work done on a piece rate plan. The piece rate is not changed without also revising the standard cost, but frequently work is done on an hourly wage basis instead of piecework. Use of piece rate as the only standard can be defended on the ground that it represents a condition which it is desired to attain and that any debit variance arising because some work is done on an hourly wage represents a deviation from the desired level of efficiency; yet at the same time there are few instances where all work can be paid for on a piecework basis. Among reasons for such **day work** are provision of a fair wage for new employees, provision of a fair wage to employees working under nonstandard conditions, or allowance for a non-routine operation on which no piece rate has been set.

Changes from piece rate to hourly wage result in labor price variances where standard costs are based on the piecework rate, for efficiency is likely to be lower under a time wage than under a piecework plan of compensation. For this reason it is desirable to have a separate standard for work done on an hourly wage basis, in order that such operations receive the benefits of standards for their control.

Keller (Management Accounting for Profit Control) reports that, in some instances, when wage increases are granted the piecework rates are not revised. Instead a flat amount per hour worked is added to the piece rate earnings. Keller states:

When this is done it is necessary to add an increment to the piece rates to provide for the added rate per hour in the standard costs. Such addition is made on the basis of the time studies on which the piece rates were set. If the piece rate for a given item is $0.15, and that is based on a standard of 1/10 hour per piece, an added hourly increment of $0.12 would result in a standard cost of $0.15 plus 1/10 of $0.12, or $0.162 per piece.

Allowed Time Per Unit Plan. Bennett (Standard Costs: How They Serve Modern Management) presents allowed time per unit as an alternative to the piece rate plan. He indicates that: "The two methods are essentially the same, except as to whether the worker will earn money per unit or time per unit, which will later be translated into money by multiplying the time earned by the hourly base rate as shown by the job evaluation."

The piece rate approach is simpler, but its weakness is that "if the base hourly rates are changed, all of the piece rates will have to be recalculated. If allowed time per unit is used, these rates in terms of time will not be changed if the hourly rate bases are changed."

Multiple Piece Rate, Bonus, and Premium Plans. If multiple piece rate, bonus, or premium plans are in effect, Neuner (Cost Accounting) says that the cost accountant must ascertain from management answers to questions such as:

1. Is the premium or bonus to be considered as part of the direct labor cost?
2. Will the standard used in computing the bonuses be the same as the standard used on the cost sheets? If not, what differences or adjustments must be considered?

Multiple piece rate, bonus, and premium plans usually involve several wage rates depending upon the volume of the worker's production. Sometimes bonuses are paid on the **quality of production** in addition to, or rather than, bonuses based on **quantity of production.** Certain plans, such as the Halsey, Gantt, and Bedaux plans, are characterized by varying **earnings curves.** Where incentive wage systems of this character are in use, labor cost per unit of output varies according to the rate of output and also according to the type of earnings curve that the wage plan yields. Thus direct labor cost per unit of output is, under multiple piece rate plans, constant within the limits to which each rate applies but contains a "step" for each rate. Premium and bonus wage plans yield various direct labor cost curves as output is increased, depending upon the nature of a particular compensation plan. Some provide a **continuous unit cost curve** which declines, others present a **discontinuous cost curve,** and a number of plans yield a labor cost curve which first declines and then continues parallel to the horizontal axis of the chart. Multiple piece rates give unit labor costs which rise as output increases over a considerable range, whereas the common bonus and premium plans give declining unit labor costs.

Under systems discussed in the preceding paragraph, there are two different practices with respect to the output level at which the standard is set:

1. To assume that 100% level of output is a reasonable one that ought to be attained, and to set the standard at the wage rate paid for this degree of efficiency. When examining the resulting variance figures, management must keep in mind that a debit balance in the **labor rate variance** amount may be justified when it has resulted from a high level of output under a wage system that has been deliberately designed to yield an increasing **unit labor cost** with increases in worker output. It may also be noted that wage plans such as the Wennerlund bonus yield a constant unit labor cost at efficiencies over 100%, and hence there is no price variance when output is at or above the 100% level.

2. To assume that the standard labor rate should include the **average bonus** or **premium earned.** This method differs from the foregoing only in the level at which the standard is set. However, in setting the standard, it becomes necessary to study past performance records to ascertain what bonus is most commonly earned. If such records are lacking, the rate setter's expectations concerning what an average worker will earn under the plan may be adopted instead.

The choice between the above levels is best made according to the underlying policy upon which the wage payment plan has been constructed. Where the 100% level gives the rate of production and compensation which the average worker is expected to earn, it is the preferable level at which to set the standard. On the other hand, if the wage payment curve is constructed in such a fashion that the average worker is able to earn a bonus consistently, then the labor price standard should be set at this level.

The practicality of incentive plans involving the use of a curve is questioned by Bennett (Standard Costs: How They Serve Modern Management). He says the curves are "often marvels of interesting engineering complications. The present-day approach to wage incentives is to discard these complicated plans in favor of simple, practical methods."

Crew or Gang Rates Plan. In many production situations the operation (or operations) is performed by a crew of men working together as a group. In such cases the output of each man is limited by the performance of the least efficient member of the crew or of the speed of the machine they are operating. The standard must therefore be set for the crew as a unit. The mechanics of this, as described by Keller (Management Accounting for Profit Control), are:

Various skills and wage rates may be included in the crew. The rate applied to the standard hours to determine standard costs is a composite for the crew. In a fiber-board mill the crew of the forming machine would include the following crew and hourly rates: one machine tender at $2.10, one pulp operator at $1.90, one wet-saw operator at $1.80, and three helpers at $1.60, resulting in a composite rate of $10.60 per hour. With the operation paced by the speed of the machine and a standard of 0.45 hours per 1,000 square feet, including allowance for delays, the standard direct labor cost is $4.77 per 1,000 square feet.

Group incentive-pay plans would affect the setting of labor rate standards for the group, much as they affect the setting of labor rate standards for individuals, as discussed in the preceding paragraphs.

Manufacturing Overhead Standards

NATURE OF MANUFACTURING OVERHEAD. Manufacturing overhead consists of all manufacturing charges not directly identified with the product. **Indirect manufacturing expense** and **burden** are frequently used as synonyms for manufacturing overhead. Matz–Curry–Frank (Cost Accounting) indicate that, "Manufacturing expenses include primarily the costs of services, equipment, and materials used to expedite actual production but ordinarily not physically part of the finished product."

The nature of manufacturing overhead, or burden, is explained by Schlatter and Schlatter (Cost Accounting) as:

Burden is sometimes inaccurately thought of as a kind of unfortunate addition to the real costs of production: direct materials and direct labor. But the indirect relation of these costs to particular jobs does not alter the fact that the services received, for which these costs are incurred, are real and necessary for effective production.

Burden costs are incurred in order to make labor effective, and therefore, in a sense, they represent, along with wages, a cost of labor. It would be impossible for a firm to produce a modern industrial product if it possessed nothing but a stock of raw materials, an adequate labor force, and an intention to produce.

The NAA Research Series No. 12 (NAA Bulletin, vol. 29) emphasizes that the techniques of setting standards for overhead costs and the application of the standards must take into account the following:

In the first place, overhead covers a complex variety of costs, the individual components of which behave in different ways when activity in the plant increases or decreases. Some overhead costs vary directly and proportionately with activity; others follow activity but not in the same ratio, and still others are largely independent of activity. As a result the actual average unit cost fluctuates with changes in activity, and for this reason overhead standards for cost control are set in the form of budgets which give the total amount to be spent at a given level of activity.

Another result of the complex nature of overhead costs is that control over various items of overhead rests with different individuals in the organization. For example, foremen in productive departments may be able to control usage of indirect labor, superintendents may control factory clerical expenses, and heads of service departments control costs of supplying heat, cleaning, and plant transportation. Responsibility for costs must therefore be carefully defined.

DEPARTMENTALIZATION OF OVERHEAD. Since control over various items of overhead rests with different individuals in the organization, the setting of standards for overhead involves an analysis of expenses by operating departments of the business. Where conditions within the department are not uniform as to incurrence of overhead, **cost centers,** or subdivisions with uniform conditions, are established within the department. A cost center may be a single machine, a bank of similar machines, or a station within a department which requires a labor skill different from other stations in the department. (For a detailed discussion of cost centers, see section on Manufacturing Overhead and Product Cost.)

It is necessary that **factory service department costs** be carefully analyzed so that they may be allocated to production departments in a way that is both equitable and clerically feasible. **Unit cost rates** for services are determined wherever possible in order that direct charges to consuming departments can be made. (For a discussion of manufacturing overhead and bases of distribution, see sections on Accumulation and Distribution of Manufacturing Overhead.)

SEPARATION OF FIXED AND VARIABLE OVERHEAD COMPONENTS. In order to set standard costs for overhead, it is necessary to develop information as to the behavior of each element of overhead with respect to changes in level of output. It is a truism that certain costs do not change as a result of volume changes during a given period of time; these are commonly called **fixed costs.** Other costs increase or decrease in direct proportion with changes in volume; these are **variable costs.** Other costs remain the same in amount for a significant range of activity and then change abruptly to a different amount for another range; these are **semi-fixed costs.** Costs which vary in response to volume changes, but not in direct proportion, are sometimes called **semi-variable** costs. Customary accounting procedures mixes fixed, semi-fixed, variable, and semi-variable components of overhead cost in the accounts, so that a mere review of historical data does not indicate the cost behavior. The most useful procedure for disclosing cost behavior is the flexible budget. Some knowledge of cost behavior may be obtained from the **graphic method of approxima-**

Month ____________, 19__

	0 Hr	200 Hr	400 Hr	600 Hr	800 Hr	1,000 Hr	1,200 Hr.
	0% Capacity	20% Capacity	40% Capacity	60% Capacity	80% Capacity	100% Capacity	120% Capacity
Supervision	$ 600 00	$ 600 00	$ 600 00	$1,050 00	$1,050 00	$1,050 00	$1,500 00
Indirect Labor	300 00	600 00	900 00	1,200 00	1,500 00	1,800 00	2,100 00
Maintenance	100 00	120 00	140 00	160 00	180 00	200 00	220 00
Depreciation	1 000 00	1 000 00	1,000 00	1,000 00	1,000 00	1 000 00	1,000 00
Supplies	37 50	50 00	62 50	75 00	87 50	100 00	112 50
Power	1 072 50	1,233 00	1 393 50	1 554 00	1 714 50	1,875 00	2,035 50
Totals	$3,110 00*	$3,603 00	$4 096 00	$5,039 00	$5,532 00	$6,025 00	$6,968 00

* Fixed or stand-by cost

Normal overhead rate per direct labor hour

$$\text{Fixed element} \quad \frac{\$3\ 110}{1{,}000} = \$3\ 110$$

$$\text{Variable element} \quad \frac{\$2\ 915}{1{,}000} = \$2\ 915$$

$$\text{Total (1,000 hr = normal capacity)} = \underline{\$6\ 025}$$

Fig 8 Flexible overhead budget, Department A

tion or the arithmetic method of approximation of the fixed cost amount and the variable cost rate. (See the discussion in the section on Accumulation of Manufacturing Overhead.)

Flexible Budgets. A static budget is an operating plan for a forecasted level of activity. A flexible budget is a series of static budgets for various forecasted levels of activity. For control of manufacturing overhead (one of the prime purposes of standards), it is necessary to compare actual costs with the standard. The standard is the budgeted cost for the actual activity.

It is preferable to ascertain the budget for actual activity (the standard) by interpolation of flexible budget figures which show the true behavior of semi-fixed and semi-variable items, than it is to attempt to adjust a static budget by use of variable expense rates which spread the effect of the change smoothly over the range of activity considered.

For example, in Fig. 8 note that the "0%" column shows the fixed, or stand-by, costs of each element. The computation of the variable rate, as shown under the budget itself, includes the change in supervision expense ($450) between the zero percent activity level and the 100% activity level. Thus, included in the variable expense rate is a factor of $0.45 per direct labor hour. If actual activity were 800 hours, use of the rate would give $360 variable supervision expense. This, added to the $600 fixed supervision expense, gives a total of $960 supervision expense at 800 hours, whereas the flexible budget indicates that company policy calls for one foreman and one assistant at that activity level, resulting in $1,050 supervision expense.

For the purpose of determining standard unit product cost, the budgeted costs for a single level of activity must be used. The effect on standard overhead costs of the various assumptions that can be made as to the level of activity is discussed in a subsequent portion of this section.

Flexible budgets are usually designed to aid management in the performance of its **planning and co-ordination functions** as well as in the performance of its **control function.** For these purposes it is usually considered desirable to base the budgets upon **expected performance.** If it is desired to base the standards upon a different level of performance, usually tighter, the budget may be prepared on the level of performance assumed in the standard (to furnish standard overhead figures) and then adjusted by forecasted variances to put it on the expected performance basis. (For a detailed discussion of budgets, see section on Cost Control, Budgets, and Reports.)

EFFECT OF ASSUMED OUTPUT LEVEL ON OVERHEAD STANDARDS. Four output levels upon which standards may be based are distinguished earlier in this section: the **theoretical,** the **practical,** the **normal,** and the **expected.**

The capacity assumptions have particular significance in the setting of overhead standards because of the effect of the fixed and variable portions of overhead cost. Lang–McFarland–Schiff (Cost Accounting) indicate that the **expected** and **normal** levels tend in practice to become the same as an **average** level. Inasmuch as the **theoretical** level is not in common usage, these authorities say that in reality, **standard capacity** may be defined in two ways:

1. The **practical capacity** of a plant to produce, or what a plant could do if there were no lack of orders. This is less than the maximum physical capacity by the amount of unavoidable idleness for repairs, unforeseeable breakdown, shortages of material or labor, and other interruptions that are not humanly preventable.

2. The **average capacity** of a plant to produce and sell. This view of standard capacity allows both for unavoidable interruptions in a factory and for an average amount of idleness due to lack of sales orders.

Either practical or average capacity may be defined on the basis of a one-, two-, or three-shift day and for whatever length of working week the management of the company expects to maintain. Capacity can, of course, be measured in machine hours, or labor dollars, as well as labor hours, whichever is most convenient in a given instance. (Plant capacity is treated in detail in the section on Manufacturing Overhead and Normal Activity.)

Overhead Absorption Based on Average Capacity. Using the condensed, flexible, overhead budget illustrated here as an example, and assuming that the average capacity of the department is 8,000 hours, the standard amount of overhead is $20,000 in total. The total is made up of $8,000 fixed cost and $12,000 variable cost. The **standard overhead rate** is therefore $2.50 per hour ($20,000 ÷ 8,000 hours), reflecting a rate of $1.00 per hour for the fixed cost, and $1.50 per hour for the variable cost.

Condensed Flexible Overhead Budget

Department A

	6,000 Hr.	8,000 Hr.	10,000 Hr.
Fixed Expenses	$ 8,000	$ 8,000	$ 8,000
Variable Expenses	9,000	12,000	15,000
Total	$17,000	$20,000	$23,000

Overhead Absorption Based on Practical Capacity. Using the condensed overhead budget illustrated in the table, and assuming that the practical capacity of the department is 10,000 hours, the standard amount of overhead is $23,000 in total. The total is made up of $8,000 fixed cost and $15,000 variable cost. The standard overhead rate is therefore $2.30 per hour, reflecting a rate of $0.80 per hour for the fixed cost and $1.50 per hour for the variable cost.

Practical vs. Average Capacity. The standard overhead rate based on the average output level, according to the foregoing example, is $2.50; the standard overhead rate based on the practical output level in the same example is $2.30. The difference between the two rates rests solely upon the fixed cost factor; the variable rate is the same at both levels It is important to realize that the output level chosen as a basis for the standard rate affects the **capacity variation** or **volume variation** from standard: All the fixed cost is charged to production only if the actual time worked is equal to the standard time. Inasmuch as the cost of **idle capacity** reported to management will vary according to the choice of standard output level made, both management and accountants should review the arguments presented by the proponents of practical capacity and by the proponents of average capacity. These are discussed in the section on Manufacturing Overhead and Normal Activity.

Setting Standards and Evaluating Performance

RELATION OF STANDARD COSTS TO ORGANIZATION CHART. With regard to the **control objective** of standard costs, Matz–Curry–Frank (Cost Accounting) say, "An expense cannot be controlled unless responsibility of con-

trol has been assigned. The assignment is directed by the organization chart which in turn, follows the departmentalization of the company." Bennett (Standard Costs: How They Serve Modern Management) emphasizes:

> Certainly no attempt should ever be made to devise or install standard cost methods or procedures until the organization has been thoroughly studied, its weak points located and reviewed with management, and a program of correction determined upon and made effective. To proceed with the standard costs without benefit of proper organization would be like building a house without a foundation.

MANAGEMENT RESPONSIBILITY. Three levels of management in a firm are usually distinguished: top management, middle management, and direct supervisory management.

Responsibility of Top Management. The top management of a firm is the small group of individuals responsible for **planning, organizing,** and **controlling** the business as a whole. This group has the ultimate responsibility for all decisions. Therefore all the plans and policies upon which a standard cost system is based are traceable to the top management group. The support of top management is essential to the success of any standard cost installation. Setting standards which will prove useful to all levels of management involves **education of management, accounting, engineering, and operating personnel** in the uses and limitations of standards set in accord with the assumptions chosen. If top management is not sold on standards, there is often not enough incentive for others to do the necessary thinking and working to make the standards useful.

Responsibility of Middle Management. Heads of major divisions or departments of the business are known as the middle management group. Individuals in this group have the responsibility for seeing that subordinates meet their standards. Additionally, heads of major divisions are directly responsible for departmental costs not controlled by subordinates. Middle management is concerned with the detailed plans and policies which are reflected in **departmental overhead budgets.** This group must be consulted in the **establishment of cost centers** for overhead standards and must also agree as to the reasonableness of materials and labor standards which they must meet.

Responsibility of Direct Supervisory Management. Foremen, sales managers, and others who supervise the performance of employees comprise the third level of management as direct supervisory management. Ackerman (NAA Bulletin, vol. 31) says these are "the people who make or break a standard cost system." Individuals in this group are not concerned with long-term planning, ordinarily, but they are vitally concerned with day-to-day problems in the **utilization of materials and labor** and some elements of overhead. This group should be consulted in the establishment of standards if their performance is to be judged by those standards.

Responsibility of Functional Management Groups. Functional managerial groups make decisions that have definite bearing on the problem of setting standards. Bennett (Industrial Accountants' Handbook, Fiske and Beckett, eds.) presents a concise listing of such decisions by the functional management group:

1. Top management decisions.
   a. Plant-operating hours.
   b. Kinds and volume of goods to be produced and sold.
2. Engineering management decisions.
   a. Product design.
   b. Product specifications.

3. Manufacturing management decisions.
   a. Personnel requirements.
   b. Manufacturing burden requirements.
4. Sales management decisions.
   a. Prices at which goods can be sold.
   b. Personnel requirements.
   c. Other distribution requirements.
   d. Sales burden requirements.
5. Accounting department determinations.
   a. Operating budgets to reflect the several management decisions.
   b. Standard costs for all products based on these decisions.

With respect to the preceding list, Bennett (Standard Costs: How They Serve Modern Management) comments: "The accounting department or cost department will be the last department to step into the program. Its job is not to determine standards or budgets, but simply to reflect in units of things and money values the budgets, standards, and standard costs that result from the decisions of the operating management."

STANDARDS COMMITTEE. The general direction and supervision of a standardization program is commonly delegated to a **standards division or committee** created for the purpose. Such a body continues in existence after the initial establishment of standards, to aid in their effective application and to make changes that are necessary as new circumstances render previous standards obsolete. In a small organization the standards committee is usually a special committee of the regular executives which meets from time to time to discuss matters of general policy and to exchange ideas, while actual work of setting and enforcing standards is under direction of the various departmental executives. In a large concern there may be a standards division with a permanent staff of experts to do the work of setting and adjusting standards.

The findings of the series of NAA research studies on standard costs relative to the responsibilities of the different departments for the setting of the various components of standard costs are presented in the appropriate portions of this section.

EVALUATING PERFORMANCE. The fact that an assumed level of performance is inherent in standards is brought out in an earlier portion of this section. In addition to evaluating the performance of direct labor, standards are useful in evaluating the performance of supervisors in controlling the usage of materials and overhead items, the performance of purchasing personnel in obtaining the most advantageous prices and methods of delivery, and the performance of the sales department in getting sales orders to utilize capacity. In short, to paraphrase the words of Blocker and Weltmer (Cost Accounting), the goal of a business is efficient operation, and the reaching of the goal is signified by the **attainment of standards.**

The management of a small business may be so close to every detail that the standards it uses to evaluate performance need not be written. "Since management of a large establishment cannot follow every detail so immediately," Goetz (Management Planning and Control) points out, "the job is delegated to the system of standards, records, and reports. Deviations of performance from standard are investigated and reported to appropriate executives." In cost accounting terminology these deviations are usually known as **variances.**

For purposes of evaluating performance, **ideal,** or perfection, standards may be used as well as **attainable** standards. Keller (Management Accounting for

Profit Control) emphasizes the importance of **retention of work sheets** used in setting standards, and the approval of standards when standards are used for evaluating performance:

It is important that the detail work sheets used in developing perfection standards be retained during the period the standards are in use. They are used for relatively long periods, and frequent reference to them is necessary in analyzing actual performance and interpreting variations. The standards themselves are recorded on appropriate forms and are approved by the appropriate members of the orgnization, just as are the attainable standards.

The **effects of evaluating performance** in one company are reported by Canfield (NAA Bulletin, vol. 35):

The number of employees, labor hours, and labor costs were reduced substantially by application of these standards and of the incentive system. There were other reductions which flowed from this. Overhead costs were reduced through reduction in costs for employee benefits on account of reduction in personnel and in labor hours and through reduction in the number of furnace-hours required. The removal of production bottlenecks was accomplished through reduction in furnace-hours required. Through this reduction, possible expansion of heat-treat activity is now permitted without purchase of additional facilities.

Management can take action on variances from standard only if it receives prompt, meaningful reports. **Variance reports** take many forms. (This is discussed in detail in the section on Analysis and Control of Standard Cost Variances.)

Human Reactions to Standards and Controls. The importance of obtaining favorable human reactions to standards and controls must be recognized. Unless the reactions are favorable, often the standards will be disregarded and will contribute little to the efficient operation of the organization. The section on Cost Control, Budgets, and Reports contains a comprehensive treatment of this subject.

REVISION OF STANDARDS. In dealing with the role of variances in cost control, the NAA Research Series No. 22 (NAA Bulletin, vol. 33) states:

Control over current costs must obviously be exercised before the fact rather than after the fact. Preventive cost control depends upon actions taken at the point where losses and waste can occur, or where savings can be made. This type of control uses basic operating standards expressed in terms of material specifications, operation methods and times, preferred equipment and facilities. Such standards need to be current at all times, i.e., they must represent the methods which should be followed when the work is done. Among the companies which were judged to be making effective application of standard costs for cost control, comments were often made to the effect that such standards "are under continuous review and are changed whenever necessary."

Current standard costs must be revised when prices, manufacturing methods, product specifications, or other circumstances change to such an extent that the standard no longer represents a good measure of performance. It is also necessary to revise standards which are found to have been incorrectly set. This should be done only when the existing standard is clearly erroneous, for the objective of standards is defeated if management does not resist any tendency to lower standards rather than to raise performance.

Basic standard costs usually are revised only when methods of manufacturing change, when plant capacity changes, or when the disparity between the basic

standard and expected performance becomes so great that the standard loses its significance. This is in contrast to **current standards** which require complete review each year as new budgets are prepared. Since the principal value of basic standards lies in their use as fixed points, or **bench marks,** from which to measure changes, they must remain as stable as possible.

According to NAA Research Series No. 22 (NAA Bulletin, vol. 33):

Most companies review their standard costs periodically and revise them when it is found that the standard product costs in use are no longer the proper ones for the purpose. The field study shows that this revision of standard product costs usually takes place just prior to the annual closing. Up-to-date standard product costs are therefore available for costing the year-end inventory and as a basis for decisions made at that time.

Effective Date of Standards. The question of when the change in standards becomes effective is important for cost accounting purposes. If the changes are to be retroactive, it is necessary to revise inventory and income accounts. On the other hand, if changes are to apply only to goods manufactured in the future, no adjustment of the accounts is required. Changes in the standard price of materials or correction of erroneous usage and utilization standards generally affect only the work performed subsequent to the revision of standard costs. When jobs already started are to be finished under the old standards and new jobs are to come under different standards, it is convenient to open new ledger accounts for work to which the changed standards apply. Two sets of **Work-in-Process** accounts are thus carried for a time, but the old accounts are closed as soon as jobs in process under the old standards are completed.

An alternative method, utilizing a **Change in Standards Variance** account, is described by Gillespie (Cost Accounting and Control):

When the number of standard cost cards is very large, it may be particularly desirable to continue the old standard costs in the Inventory and Cost of Sales accounts until the end of the style season, thus:

Work in Process		Finished Goods		Cost of Goods Sold	
	Old standard $.20	Old standard $.20	Old standard $.20	Old standard $.20	

After the new standard for the operation is put into effect, Work in Process will be charged for the new standard. Continuing the above illustration relating to one labor operation on one unit of product, Work in Process would stand charged at the new standard and credited at the old standard:

Cash		Work in Process	
	$.18	New standard $.18	Old standard $.20

At the end of the period, the change of standard variance would be taken out of Work in Process by a debit to Work in Process for $.02 and a credit to Change of Standards Variance for the same amount. Of course the actual amount of the entry would be determined by multiplying the number of units processed through the operation by the $.02 saving. The credit balance in the Change of Standards Variance account represents cost reduction through devising new methods and installing new standards.

See also Journal Entries for Revision of Standards in section on Operation of Standard Costs.

Markell (NAA Bulletin, vol. 36) likens the process of standards review and revision to the process of setting standards originally. Some of the review benefits noted in one firm, he writes, are:

The annual standards review, itself, provides a dynamic incentive to plant management to keep the wheels of progressive improvement rolling. This is a result of the absoluteness of the report of standards change and the specific time interval it covers. Historically, these reports also provide an excellent description of trends experienced over the years, with explanations of the dominant influences causing these trends.

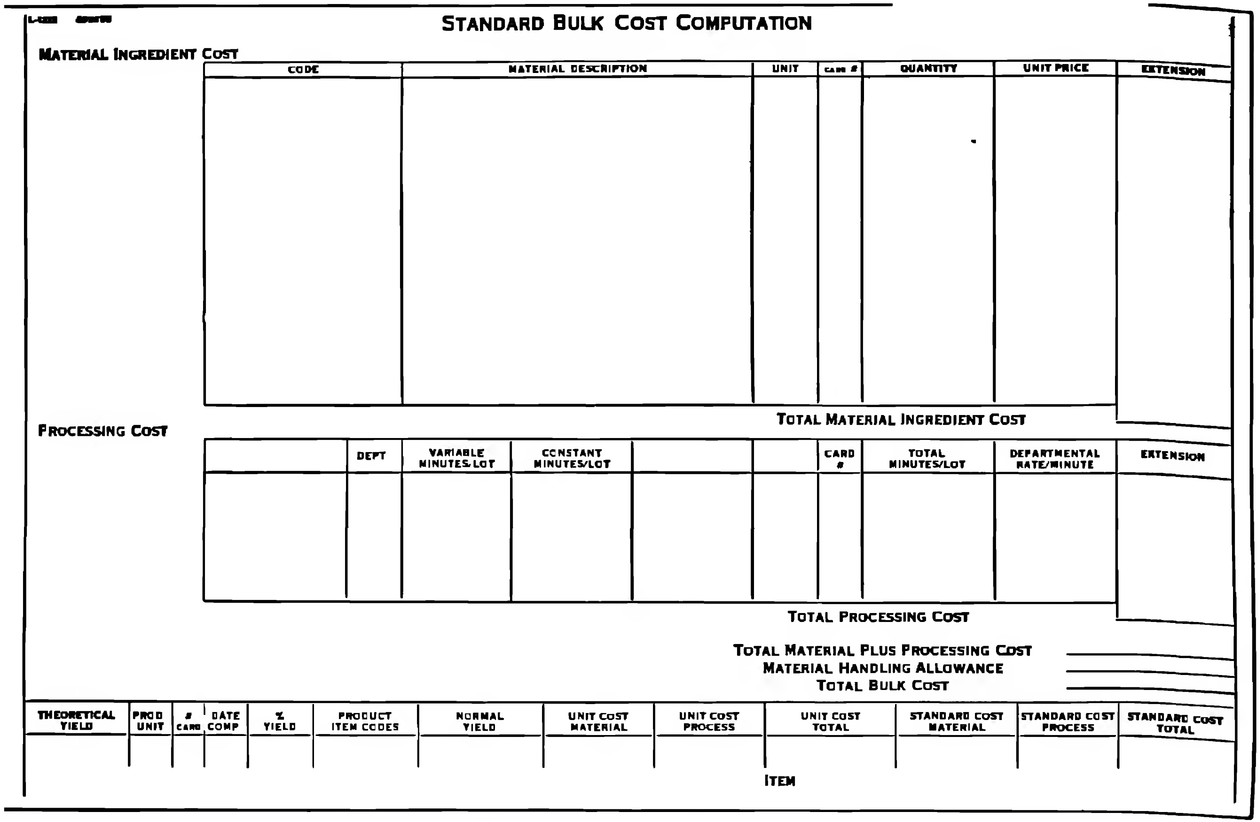
Organizing Standard Cost Records

TYPES OF STANDARD COST RECORDS. A complete set of standard cost cards and records must be prepared. These begin with **manufacturing specification cards,** showing how each operation is to be performed and what elements of materials, labor, and services should be consumed. These physical specifications are then priced at standard costs and the results posted to **standard cost cards** which show the standard cost of each element entering into a unit of product. The number and complexity of these cards depend upon the size and characteristics of the business. A plant producing thousands of different articles naturally has need for many more cards than one producing a single article. The presence of a complicated manufacturing process in which parts are produced and then brought together into subassemblies before completion also requires more highly organized standard cost records than one where the manufacturing process is simple. However, no great difficulties are involved, for the standard cost cards can be organized on the same principle now familiar in handling accounting records; i.e., the records are arranged to follow operation sequence, details being provided where needed, and then posted in summary as the item progresses until at completion a single figure representing the completed standard cost of a product results.

SUMMARY AND SUPPORTING RECORDS OF STANDARDS. The standard costs of direct materials, direct labor, and manufacturing overhead for each product are entered on a **summary record,** usually called a "standard cost card." The form of the summary record should, of course, be varied to suit the conditions existing in each plant or industry. Fig. 9 is an example of a standard cost card used by a firm which includes direct labor and manufacturing overhead in "processing cost." Therefore two sections appear on Fig. 9: Material Ingredient Cost, and Processing Cost. Data are reproduced on the bottom line of the form to facilitate the analysis of variances between actual and standard product costs. Supporting the Material Ingredient Cost Section of Fig. 9 is a **materials formula** (not illustrated). A **master methods sheet,** Fig. 10, supports the Processing Cost section of Fig. 9.

Figs. 1, 2, 3, 6, and 7 illustrate forms of standard raw materials lists, standard parts charts, parts drawings, route sheets, and drawing and standard layout charts, respectively. In many firms a number of these supporting forms are combined and become sections of the summary record itself. Fig. 11 illustrates a **shop order** used by an electronics firm which combines raw materials lists, purchased parts lists, route sheets, assembly specifications, labor grade specifications, and standard costs for materials, labor, and overhead.

Figs. 5 and 6 present the subassembly bill of materials and subassembly route sheet for a blower assembly "G–700177." The standard cost of this assembly is



STANDARD BULK COST COMPUTATION

MATERIAL INGREDIENT COST

CODE	MATERIAL DESCRIPTION	UNIT	CARD #	QUANTITY	UNIT PRICE	EXTENSION

TOTAL MATERIAL INGREDIENT COST

PROCESSING COST

	DEPT	VARIABLE MINUTES/LOT	CONSTANT MINUTES/LOT			CARD #	TOTAL MINUTES/LOT	DEPARTMENTAL RATE/MINUTE	EXTENSION

TOTAL PROCESSING COST

TOTAL MATERIAL PLUS PROCESSING COST
MATERIAL HANDLING ALLOWANCE
TOTAL BULK COST

THEORETICAL YIELD	PROD UNIT	# CARD	DATE COMP	% YIELD	PRODUCT ITEM CODES	NORMAL YIELD	UNIT COST MATERIAL	UNIT COST PROCESS	UNIT COST TOTAL	STANDARD COST MATERIAL	STANDARD COST PROCESS	STANDARD COST TOTAL

ITEM

Fig. 9. Standard cost card.

MASTER METHODS SHEET
Dry Products Manufacturing Dept., M-342

ITEM__________________ YIELD__________

Operation	Class	No. Lb.	No. Sect.	Std. Min./ Lb.	Std. Min./ Sect.	Var. Min./ Tkt.	Min. per M Tabs.	Min./ Tkt.	Folder Number
Triturate									G-
Bolt									G-
Machine mass									G-
Granulate									G-
Sieve wet									G-
Sieve dry									G-
Mix dry									G-
Hammer mill or grind									G-
Security sieve									G-
Bolt									G-
Compress									G-
Clean-up compression mach.									G-
Additional clean-ups									G-
Additional tray tag time									
		No. Pans	No. Drums	Std. Min./ Pan	Std. Min./ Drum				
Coat and polish									G-
Fuse									G-
Sort									G-
Column totals									------
Variable Min./Lot + Yield =									------
Total minutes									------
									G-
INDEX STANDARD TIME ALLOWANCES									

Effective date__________ Set by__________ Approved by__________

Fig. 10. Master methods sheet.

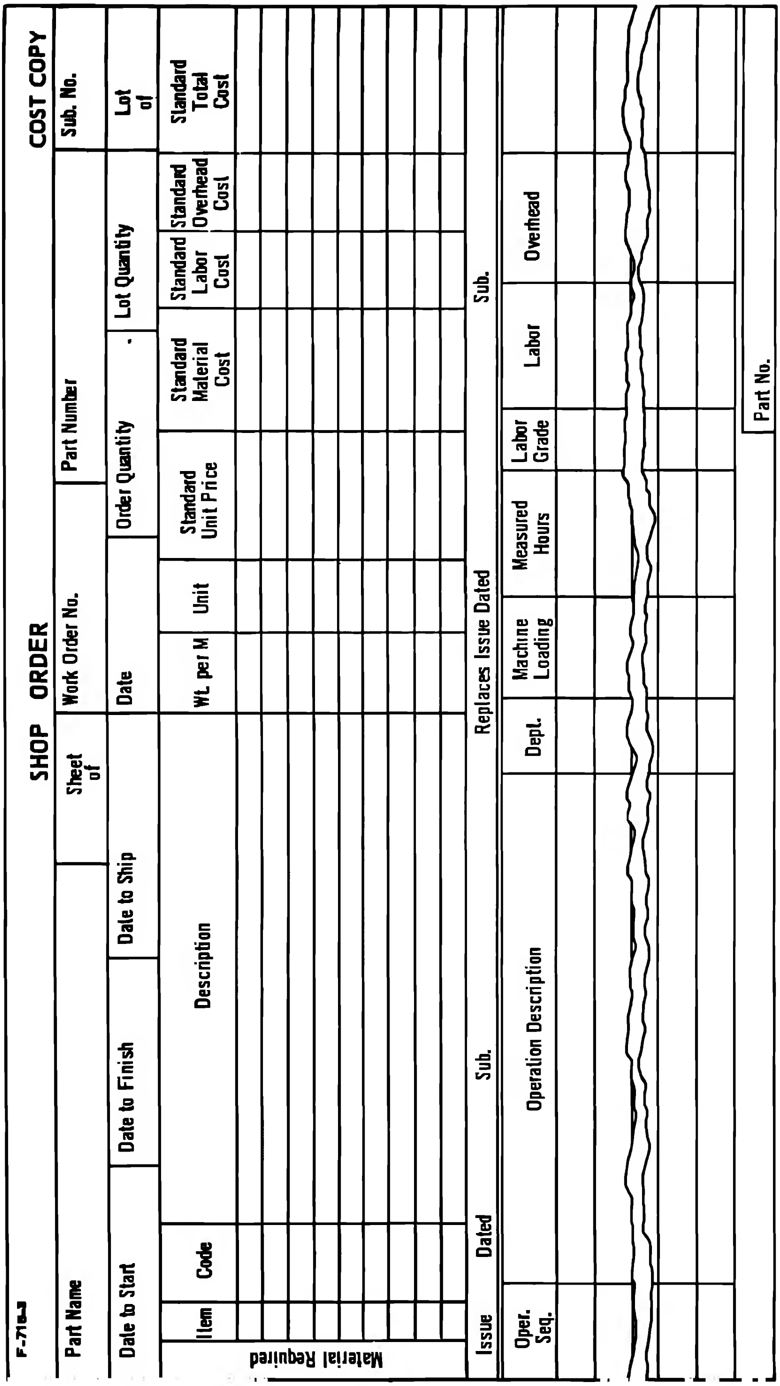


Fig. 11. Combined summary and supporting standard cost record.

RAW MATERIAL	PURCH. MATERIAL	MAT'L HAND	FACT SUP	SUB TOTAL	LABOR	BURDEN	OVERHEAD	TOTAL	PART NUMBER
209 19	17,479 88	1,248 49	26 53	$ 18,964 69	588 76	1,459 72	999 32	$ 20,951 39	G 700177

800	801	805	806	810	812	814	816	818	819	820
		25 / 9 35	75 / 20 84			7 08 / 58 83			116 96	

821	822	823	824	825	826	827	828	829	TOTAL 6 58
48 30		7 15		64 47					(Hrs.) 378 14

REQ.	PART NUMBER	NAME	REQ.	PART NUMBER	NAME
1	G-700180	Housing Assy			Factory Supplies
1	G-700148	Bracket Assy - Motor Mt			Paint $ 21.45
3	700146	Mount - Shock			Cal Plate $ 5.08
1	489620	Motor			
1	488993	Grommet			
1	G-488932	Wheel Assy - Blower			
2	487357	Screw			
1	487283	Nut			
1	G-486216	Lead Assy - Ground			
2	475005	Lockwasher			
4	170920	Screw			
	G-700177	Blower Assy			

Fig. 12. Assembly standard cost record.

Standards To Be Developed for	Type of Standard To Be Used	Standards To Be Reflected in Form of	Responsibility for Supervision of Setting Standards	Date To Be Completed 19__
Direct Material				
1. Standard quality of materials.	Ideal	Standard bill of materials	Chief Industrial Engineer	July 31
2. Standard quantities for products.	Bare minimum	Standard bill of materials	Production Engineer	August 31
3. Standard prices of materials.	Current at expected actual level	Standard price record	Purchasing Agent and Controller	October 15
Direct Labor				
1. Standard operation time for all manual and machine operations.	Basic or ideal	Operation and process standard time record	Chief Industrial Engineer	October 31
2. Standard direct labor rates.	Current at expected actual level	Operation standard rate record	Chief Industrial Engineer	October 31
Capacity				
1. Standard productive output.	Current at normal level	Manufacturing cost center standard capacity record	Sales Manager and Production Engineer	July 31
2. Standard operating activity.	Current at normal level	Service cost center standard capacity record	Production Engineer and Cost Accountant	July 31

verhead Expenses				
1. Standard expense amounts for each overhead account in each cost center...	Current at normal level	Cost center standard expense record	Cost Accountant and Plant Auditor	September 30
2. Standard distribution rates for each service cost center..................	Current at expected level	Service cost center standard distribution rate record	Cost Accountant and Plant Auditor	September 30
3. Standard burden rate for each producing cost center......................	Current at normal level	Producing cost center standard burden rate record	Cost Accountant and Plant Auditor	October 31
4. Budget allowances for each overhead expense account in each cost center...	Current at expected actual	Flexible budgets	Cost Accountant and Plant Auditor	October 31
5. Standard unit product costs...........	Combination of preceding standards	Standard product cost record	Cost Accountant and Plant Auditor	November 15

Fig. 13. Time schedule for setting standards.

summarized on a **total assembly cost record,** Fig. 12. In this firm a distinction is made between "burden" and "overhead." The former consists of departmental charges controllable by the department head, such as repairs and maintenance; the latter consists of the expenses of service departments, such as Production Control, Personnel, Factory Accounting, and Industrial Engineering. The costs of such service departments as Receiving, Receiving Inspection, Purchasing, and Stores are included in the "Materials Handling" standard cost.

Time Schedule for Completion of Standards. The process of setting standard costs involves considerable effort by many people. Management must make many choices from among possible alternative assumptions as to price levels, performance levels, and output levels on which standards may be based. Once the assumptions are made, engineering, purchasing, production, sales, and accounting personnel must make co-ordinated studies to determine materials, labor, and overhead standards. Under such conditions it is necessary to establish a time schedule for the completion of the project. Van Sickle (Cases in Cost Accounting) presents a chart (Fig. 13) to summarize the types of standards to be used for each component of cost, the forms to be used, the individuals responsible, and the date each individual is to complete his work.

SECTION 16

OPERATION OF STANDARD COSTS

CONTENTS

SECTION 16

OPERATION OF STANDARD COSTS

Standards in Books of Account

INCORPORATING STANDARD COSTS IN THE ACCOUNTS. An NAA research study (NAA Research Series No. 13, NAA Bulletin, vol. 29) reports that of 72 companies studied which were using standard costs, all but four had the standard costs entered on their books. In general, incorporating standard costs into the regular double-entry records has the same advantages that come from having historical cost accounts "tied in" with the financial accounts:

1. Accuracy of clerical work is improved when **double-entry** balancing techniques are used.
2. Data drawn from the accounts receive more serious attention from executives.

Those who view standard costs as the true costs naturally introduce standard costs into the ledgers and financial statements. When the accounts are properly handled, accuracy and reliability of financial statements are enhanced.

USE OF STANDARD COSTS FOR STATISTICAL PURPOSES ONLY. Although standard costs are generally incorporated in the accounts, some concerns prefer to use them for purely statistical purposes. Henrici (Standard Costs for Manufacturing) states that they may be used in this fashion when standards are being first introduced into a plant. At that time standards are normally introduced into one department at a time, and they may be used and refined in these departments before being incorporated into the records. Blocker and Weltmer (Cost Accounting) state that it may also be necessary to use them in this way in **special order plants** where it is impractical or impossible to set standards for all products. Under such circumstances **standard cost cards** can be prepared for those processes, machine and labor operations, etc., which can be standardized. These standards are entered on the production orders of the jobs for which they are available, and comparison is made by production order with the actual costs.

ACCEPTABILITY OF STANDARD COSTS FOR INCOME TAX RETURNS. In discussing the recording of standard costs in the accounts, the question naturally arises as to whether **inventory** and **net income** figures arrived at through the use of standard costs may be used in federal income tax returns. Little has been published on this question. Lafferty (NAA Bulletin, vol. 29) writes that the Internal Revenue Service "does not specifically accept standard costs as a basis for inventory values in the tax return. A search of tax decisions dealing with inventory valuation has not revealed any case dealing with standard costs." Lafferty further comments that it is generally recognized that the Service "has a marked fondness for 'cost or market, whichever is the lower' and that the cost referred to is actual costs arrived at through any of the different

manners of derivation such as first-in, first-out, last-in, first-out; or average costs." He notes that in the past the Internal Revenue Service "has accepted standard costs for inventory valuation where they approximate actual costs and in all probability will continue to do so in the future."

Vance (Theory and Technique of Cost Accounting) comments that "standard costs are accepted for federal income tax purposes when they approximate actual costs."

METHODS FOR DETERMINING VARIANCES FROM STANDARD. The terms "variance" and "variation" are both used to describe the arithmetic difference between historical cost and standard cost in a given situation. In general, the terms are used interchangeably in cost accounting literature, but since the emphasis appears to be on the use of "variance," this is followed in the main in this and other sections of this Handbook. There are two basic methods for determining the variances from standard:

1. Determining the variances on the basis of **output.** Under this method the actual production for the period by product is determined and multiplied by the appropriate unit standard costs. Comparison is then made with the actual costs. This method is commonly used in **continuous process cost systems** where it is impossible or unnecessary to distinguish production lots. It must be used when requisitions are not made out for direct materials, and/or time tickets are not made out for direct labor.
2. Determining the variances on the basis of **input.** Under this method, variances are obtained from original media such as purchase invoices, material requisitions, and time tickets. Actual as well as standard costs are entered on each of these types of forms, and the variances are then accumulated to get the totals for the period. This method is normally used with **specific order cost systems** but may be used wherever direct material requisitions and direct labor time tickets are used.

METHODS FOR RECORDING STANDARD COSTS. Considerable variation exists in bookkeeping methods for handling standard costs. Gillespie (Accounting Procedure for Standard Costs) comments, "There appear to be no universally accepted terms in the literature of standard costs to identify the methods of operating work in process accounts, although there are terms which describe types of cost." He states that in general there are three methods of recording standard costs in the accounts and describes them as follows:

Method A: Charge work in process with actual cost and credit with standard cost of production (finished goods completed and work-in-process inventory).

Method B: Charge work in process with standard cost of operations completed and credit with standard cost of finished goods completed.

Method C: Charge work in process with actual and standard cost of operations completed and credit with actual and standard cost of finished goods completed. (This method requires the use of work-in-process accounts with two debit and two credit money columns.)

Methods A and B employ current standard costs, i.e., the inventories are carried at the current standard figure. Method C utilizes bogey [or basic] standards. Under this method, the actual figure and not the bogey standard represents the inventory "per books."

Each of the principal methods are described in this section and some of the variations of each are mentioned. Method A is referred to here as the **partial plan.** The **output method** of accumulating standards is commonly used with it.

Method B is described in this section as the **single plan** and commonly uses the **input method**. The term **dual plan** is used in the subsequent discussion for Method C.

Bennett (Standard Costs: How They Serve Modern Management) also recognizes three methods of recording standard costs in the accounts. His first two are essentially the same as the above Method A and Method B illustrated here in detail as the partial plan and the single plan. For his third method, however, instead of the dual plan illustrated here, he describes a method of controlling the standard costs in the **subsidiary records** only. Of this method he says:

> All that Method 3 should eliminate is the detail of journalizing the entries each month. The procedural steps, up to the point of formalizing them in the general ledger, will not be changed. Instead of ledger accounts for perpetual inventories, cost variances, burden clearing details, cost of sales, and other monthly transactions, informal equivalent figures will be collected on work sheets, and from these the cost controls and the monthly financial and operating reports will be prepared.
>
> Method 3 is not a substitute for accounting control of costs. It is, instead, an informal method of obtaining accounting control in those cases where, for any reason, the more formalized procedures may not appear to be desirable.

Blocker and Weltmer (Cost Accounting) have essentially the same threefold breakdown as Bennett, and like him they do not specify the use of basic (bogey) standards in the third method. Blocker and Weltmer express the opinion that probably the most commonly used method is that of recording standard costs in subsidiary records only and of having the subsidiary records show both standard and actual figures, i.e.. a form of statistical costs referred to above.

In the discussion of all the various ways of entering standard costs in the accounts, we should not lose sight of the basic fact that standard costs may be used in either a **job order** or **process cost** situation.

TYPES OF VARIANCE CALCULATIONS. Variances from standard cost can be expressed in either **absolute** or **relative numbers**. By the first method the variance is computed by subtracting actual cost from standard cost. If the actual exceeds the standard cost, the variance is a negative figure (i.e., unfavorable and representing a variance loss); if actual cost is less than standard cost, the variance is a positive figure (i.e., favorable and representing a variance gain). This method of expressing variances is one which centers the attention of management upon dollar amounts of variation from standard costs.

By the second method, the variance is computed by dividing the standard cost figure into the actual cost figure to obtain the actual cost as a percentage of standard cost. Since standard cost is always the base for comparison, the standard cost is considered as 100%. When actual cost has thus been converted to percentages of standard, the actual cost percentage figure can be subtracted from the standard cost percentage figure (100%). The result, which may be either positive or negative, depending upon whether actual cost is less or greater than standard cost, is the **cost variance** expressed as a percentage of standard cost. In contrast with the preceding method, a **relative variation** from standard is thus provided.

These two methods present complementary aspects of the cost figures in such a manner that both are required for a complete understanding of the cost variation that has taken place. Variances which are large in terms of dollars are sometimes so small in terms of **percentages** that they pass unnoticed by management if presented in the latter form alone; on the other hand, a large percentage

variance may call attention to a substantial deviation from **standard efficiency**, yet the present actual loss in terms of dollars may be small.

Accounting for Partial Plan

Charging Work in Process at Actual Cost

CHARACTERISTICS OF PARTIAL PLAN. There are three distinctive features that characterize this method of standard costkeeping, namely:

1. Debits to work-in-process account are entered at actual cost; credits to work-in-process account are entered at standard cost. Thus, raw materials inventories are carried at actual cost, and finished goods inventories are carried at standard cost. Cost of goods sold is computed at standard cost.
2. **Variances** from standard cost are collected at the end of the accounting period after work in process has been inventoried.
3. Variances from standard cost appear as a total difference between standard and actual cost. Analysis of these variance figures requires the aid of information not available in the accounts.

ILLUSTRATION OF PARTIAL PLAN. The following facts are assumed for the illustration of the partial plan. It is further assumed that the standard

MATERIALS:				
Kind	Quantity	Standard Unit Cost	Totals	
M–1	5 units	$1.00	$ 5 00	
M–2	2 units	7.00	14.00	
M–3	12 units	2.00	24.00	
		Total Material Cost		$ 43.00
DIRECT LABOR:				
Operation Number	Standard Hours	Standard Rate per Hour		
1	5	$1.50	$ 7.50	
2	15	1.60	24.00	
3	3	1.75	5.25	
4	7	1.95	13.65	
Total Hours ..	30			
		Total Cost		$ 50.40
OVERHEAD:				
	Rate per Direct Labor Hour	Standard Hours		
Department A (Operations 1 & 2) ..	$1.00	20	$20.00	
Department B (Operations 3 & 4) ..	3.00	10	30.00	
				50 00
		Standard Unit Cost		$143.40

Fig. 1. Standard cost card, product Z.

cost data are to be accumulated by the output method. The illustration shows the operation of the manufacturing accounts by following step by step the flow of costs from the initial purchase of materials and services to the final summary of results in the financial statements. The company is assumed to be one which has two productive departments (Department A and Department B) and one service department, which is a power plant. The product goes through four operations, the first two of which are carried out in Department A, while operations 3 and 4 are carried out in Department B. Three kinds of material (designated as M-1, M-2, and M-3) are used, the first two being issued at the beginning of operation 1 and the third at the time work enters operation 3.

Entries and statements are based upon the **standard cost card** (Fig. 1), **flexible budgets** (Figs. 2–4), and the **statement of transactions** which follow.

Statement of Transactions. The following beginning inventories and transactions for the month are assumed:

1. Beginning inventories:

a. Raw materials:

Kind	Units	Actual Unit Price	Actual Cost
M–1	200	$ .91	$ 182 00
M–2	100	7.70	770.00
M–3	300	2.20	660.00
			$1,612.00

b. Work in process:

Department A: 20 units completed through operation 1; standard cost $630 00 (see computation of cost below).

Department B: None.

c. Finished goods:

10 units of product Z; standard cost $1,434.00.

2. Purchases of materials:

Kind	Units	Actual Unit Price	Actual Cost
M–1	1,000	$ .85	$ 850.00
M–2	500	7.70	3,850.00
M–3	2,000	2.20	4,400.00
			$9,100 00

3. Materials put into process:

Department	Kind	Units	Actual Unit Price	Actual Cost
A	M–1	520	$ .86	$ 447.20
A	M–2	200	7.70	1,540 00
				$1,987.20
B	M–3	1,100	2.20	2,420.00
				$4,407.20

(Average cost has been used, but any of the other pricing methods could be used.)

MONTH OF ______________, 19__

Item	0 kw.h. 0%	20,000 kw.h. 20%	40,000 kw.h. 40%	60,000 kw.h. 60%	80,000 kw.h. 80%	100,000 kw.h. 100%	120,000 kw.h. 120%
Supervision	$200.00	$200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00
Powerhouse labor	140.00	172.00	204.00	236.00	268.00	300.00	332.00
Fuel	240.00	292.00	344.00	396.00	448.00	500.00	552.00
Water	60.00	76.00	92.00	108.00	124.00	140.00	156.00
Supplies	20.00	35.00	50.00	65.00	80.00	95.00	110.00
Maintenance	25.00	60.00	95.00	130.00	165.00	200.00	235.00
Depreciation	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Taxes	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Totals	$750.00 *	$900.00	$1,050.00	$1,200.00	$1,350.00	$1,500.00	$1,650.00

* Fixed or stand-by cost.

Normal cost per kw.h.

Fixed element: $\frac{\$750}{100{,}000} = \$.0075$

Variable element: $\frac{\$750}{100{,}000} = \underline{\$.0075}$

Total (100,000 kw.h. = normal capacity) = $.015

Fig. 2. Power plant flexible budget.

MONTH OF ____________, 19__

Item	0 Hr.	400 Hr.	800 Hr.	1,200 Hr.	1,600 Hr.	2,000 Hr.	2,400 Hr.
	0% Capacity	20% Capacity	40% Capacity	60% Capacity	80% Capacity	100% Capacity	120% Capacity
Supervision	$ 250 00	$ 290.00	$ 330.00	$ 370.00	$ 410.00	$ 450.00	$ 490.00
Indirect labor	357.50	474.00	590 50	707.00	823.50	940.00	1,056.50
Supplies	30.00	36.00	42.00	48.00	54.00	60.00	66.00
Depreciation	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Taxes	75.00	75.00	75.00	75.00	75.00	75.00	75.00
Power	187.50	225.00	262.50	300.00	337.50	375.00	412.50
Totals	$1,000.00 *	$1,200 00	$1,400.00	$1,600.00	$1,800.00	$2,000.00	$2,200.00

* Fixed or stand-by cost.

Normal overhead rate per direct labor hour

Fixed element: $\frac{\$1{,}000}{2{,}000} = \$\ .50$

Variable element: $\frac{\$1{,}000}{2{,}000} = \underline{\$\ .50}$

Total (2,000 hr. = normal capacity) $= \$1.00$

Fig. 3. Flexible overhead budget, Department A.

MONTH OF ________________, 19__

Item	0 Hr. 0% Capacity	200 Hr. 20% Capacity	400 Hr. 40% Capacity	600 Hr. 60% Capacity	800 Hr. 80% Capacity	1,000 Hr. 100% Capacity	1,200 Hr. 120% Capacity
Supervision	$ 225.00	$ 250 00	$ 275.00	$ 300.00	$ 325.00	$ 350.00	$ 375.00
Indirect labor	100.00	125 00	150.00	175 00	200.00	225.00	250.00
Maintenance	100.00	120.00	140.00	160.00	180.00	200.00	220.00
Depreciation	1,000.00	1,000 00	1,000.00	1,000.00	1,000.00	1,000.00	1,000.00
Supplies	37.50	50 00	62 50	75.00	87.50	100.00	112.50
Power	562.50	675 00	787.50	900.00	1,012.50	1,125.00	1,237.50
Totals	$2,025.00 *	$2,220.00	$2,415.00	$2,610.00	$2,805.00	$3,000.00	$3,195.00

* Fixed or stand-by cost.

Normal overhead rate per direct labor hour

Fixed element: $\frac{\$2.025}{1,000} = \$2.025$

Variable element: $\frac{\$\ 975}{1,000} = \$\ .975$

Total (1,000 hr. = normal capacity) = $\underline{\$3.00}$

Fig. 4. Flexible overhead budget, Department B.

4. Direct labor used:

Department	Operation	Actual Hours	Actual Rate	Actual Payroll
A	1	525	$1.50	$ 787.50
A	2	1,540	1.65	2,541.00
		2,065		$3,328.50
B	3	230	1.80	$ 414 00
B	4	560	1.90	1,064.00
		790		$1.478.00
		2,855		$4,806.50

5. Actual overhead costs incurred:

a. Power plant:

Item	Actual Cost	
Supervision	$ 200 00	
Powerhouse labor	295 00	
Fuel	470.00	
Water	135 00	
Supplies	87 50	
Maintenance	185 00	
Depreciation	50.00	
Taxes	15.00	$1,437.50

b. Department A:

Supervision	$ 460.00	
Indirect labor	945 00	
Supplies	56 00	
Depreciation	100 00	
Taxes	75 00	1,636.00

c. Department B:

Supervision	$ 325 00	
Indirect labor	215 00	
Maintenance	190 00	
Depreciation	1,000 00	
Supplies	90 00	1,820.00
		$4,893.50

d. Power actually consumed by producing departments:

Department A: 25,000 kw.h.
Department B: 65,000 kw.h.

6. Work completed during month:

Department A: 100 units completed and transferred to Department B.
Department B: 80 units completed and transferred to finished goods.

7. Ending inventory of work in process:

Department A: 10 units, all material added, but no labor or overhead applied.
Department B: 20 units, ⅔ completed in operation 3

8. Sales:

50 units at $200.00 each.

JOURNAL ENTRIES FOR PARTIAL PLAN. The journal entries for this method are shown below, followed by explanations of the entries and figures. Fig. 5 shows a cumulative standard cost card for product Z by operations completed, a rearrangement of the standard cost card (Fig. 1) for the same product. The entries and figures are carried through to the variance calculations, the ledger accounts (Fig. 6), and the financial statements (Figs. 7 and 8).

Operation Number	Material		Labor		Overhead		Total Cost	
	Operation Cost	Cumulative Cost	Operation Cost	Cumulative Cost	Operation Cost	Cumulative Cost	Operation Cost	Cumulative Cost
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	$19.00	$19.00	$ 7.50	$ 7.50	$ 5.00	$ 5.00	$31.50	$ 31.50
2	0.00	19.00	24.00	31.50	15.00	20.00	39.00	70.50
3	24.00	43.00	5.25	36.75	9.00	29.00	38.25	108.75
4	0.00	43.00	13.65	50.40	21.00	50.00	34.65	143.40

Fig. 5. Cumulative standard cost card, product Z (by operations completed).

1. Entry for purchase of raw materials:

Raw Materials	$9,100.00	
Vouchers Payable		$9,100.00
To record actual cost of materials purchased. Subsidiary stores ledger is kept in the usual manner, using actual costs		

2. Entry for direct material put into process:

Work in Process—Department A	$1,987.20	
Work in Process—Department B	2,420.00	
Raw Materials		$4,407.20
To charge departmental Work-in-Process accounts with actual cost of materials put into process.		

3. Entry for direct labor cost incurred:

Work in Process—Department A	$3,328.50	
Work in Process—Department B	1,478.00	
Payroll Accrued		$4,806.50
To charge departmental Work-in-Process accounts with actual cost of direct labor used in productive departments.		

4. Entries for actual overhead costs:
   a. Recording service department costs—

Power Cost	$1,437.50	
Vouchers Payable, etc.		$1,437.50
To charge Power Cost account with actual costs of operating this service department.		

b. Distributing service department costs to productive departments—

Work in Process—Department A	$ 375.00	
Work in Process—Department B	1,050.00	
Power Cost		$1,425.00

To charge departmental overhead accounts with budgeted cost of power used. Fixed costs of power plant are distributed to operating departments in ratio of their capacities to demand service (25% to A, 75% to B); variable costs are charged at standard cost of $.0075 per kw.h. consumed.

c. Recording producing department direct overhead cost—

Work in Process—Department A	$1,636.00	
Work in Process—Department B	1,820.00	
Vouchers Payable, etc.		$3,456.00

To charge departmental account with actual direct overhead.

5. Entries for work completed during month:
   a. Transferring semifinished material from Department A to Department B—

Work in Process—Department B	$7,050.00	
Work in Process—Department A		$7,050.00

To transfer 100 product units from Department A to Department B at standard cost (100 × $70.50, standard cost per unit through operation 2, per Fig. 5).

b. Recording goods finished—

Finished Goods	$11,472.00	
Work in Process—Department B		$11,472.00

To transfer 80 completed units from Department B to finished goods inventory at standard cost (80 × $143.40, per Fig. 1)

6. Entries for sales:
   a. Recording selling price—

Accounts Receivable	$10,000.00	
Sales		$10,000.00

To record sale of 50 units at $200.00 each.

b. Recording cost price—

Cost of Sales	$7,170.00	
Finished Goods		$7,170.00

To transfer standard cost of goods sold from Finished Goods to Cost of Sales (50 units at standard cost of $143.40, per Fig. 1).

7. Entry for variances from standard:

Variances from Standard	$ 995.20	
Work in Process—Department A		$ 716.70
Work in Process—Department B		266.00
Power Cost		12.50

To transfer variances from standard to special account.

Raw Materials

Bal.	$ 1,612.00	(2)	$ 4,407.20
(1)	9,100.00	Bal.	6,304.80
	$10,712.00		$10,712.00
Bal.	$ 6,304.80		

Power Cost

(4a)	$ 1,437.50	(4b)	$ 1,425.00
		(7)	12.50
	$ 1,437.50		$ 1,437.50

Work in Process—Dept. A

Bal.	$ 630.00	(5a)	$ 7,050.00
(2)	1,987.20	(7)	716.70
(3)	3,328.50	Bal.	190.00
(4b)	375.00		
(4c)	1,636.00		
	$ 7,956.70		$ 7,956.70
Bal.	$ 190.00		

Work in Process—Dept. B

(2)	$ 2,420.00	(5b)	$11,472.00
(3)	1,478.00	(7)	266.00
(4b)	1,050.00	Bal.	2,080.00
(4c)	1,820.00		
(5a)	7,050.00		
	$13,818.00		$13,818.00
Bal.	$ 2,080.00		

Variances from Standard

(7)	$ 995.20	(8)P&L	$ 995.20

Finished Goods

Bal.	$ 1,434.00	(6b)	$ 7,170.00
(5b)	11,472.00	Bal.	5,736.00
	$12,906.00		$12,906.00
Bal.	$ 5,736.00		

Cost of Sales

(6b)	$ 7,170.00	(8)P&L	$ 7,170.00

Accounts Receivable

(6a)	$10,000.00		

Sales

(8)P&L	$10,000.00	(6a)	$10,000.00

Payroll Accrued

		(3)	$ 4,806.50

Vouchers Payable, etc.

Bal.	$13,993.50	(1)	$ 9,100.00
		(4a)	1,437.50
		(4c)	3,456.00
	$13,993.50		$13,993.50
		Bal.	$13,993.50

Profit and Loss

		(8)	$ 1,834.80

Capital Stock

		Bal.	$ 3,676.00

(Capital Stock in an amount just equal to the beginning inventories was assumed so that the ledger would balance.)

Fig. 6. Ledger accounts for partial plan standard costs.

The amounts are computed as follows:

	Dept. A	Dept. B	Power Dept.
Total debits at actual cost	$7,956.70	$13,818.00	$1,437.50
Standard cost of units finished	$7,050.00	$11,472.00	$1,425.00
Standard cost of ending inventory ...	190 00	2,080 00	0.00
Total credits at standard cost	$7,240.00	$13,552 00	$1,425.00
Variances from standard	$ 716.70	$ 266.00	$ 12.50

8. Entry to close expense and revenue accounts:

Sales	$10,000.00	
Cost of Sales		$7,170.00
Variances from Standard		995.20
Profit and Loss		1,834.80
To close nominal account balances		

9. **Alternative entries not posted to ledger** (Fig. 6) to allocate variances and close expense and revenue accounts:

a. Prorating variances—

Work in Process—Department A	$ 11.48	
Work in Process—Department B	131.00	
Finished Goods	378.99	
Cost of Sales	473.73	
Variances from Standard		$ 995.20
To adjust ending inventories from standard to actual on an average cost basis. (See Calculation of Amounts To Be Distributed, subsequently in this section.)		

Alternative entries not posted to ledger (Fig. 6):

b. Closing expense and revenue accounts—

Sales	$10,000.00	
Cost of Sales		$7,643.73
Profit and Loss		2,356.27
To close nominal account balances		

c. Reversing prorations—

Variances from Standard	$ 521.47	
Work in Process—Department A		$ 11.48
Work in Process—Department B		131.00
Finished Goods		378.99
To readjust beginning inventories of the new period to standard cost.		

CALCULATION OF WORK-IN-PROCESS INVENTORIES. At the end of the month, the balances in Work-in-Process accounts are composed of two elements:

1. Standard cost of unfinished work.
2. Variances from standard cost.

These latter apply both to the unfinished work as well as to the work which was completed and transferred to finished goods during the month, for Work-in-Process account has been credited only for the standard cost of goods finished. The first step in effecting a separation of work-in-process inventory from variances is an inventory of goods in process. Material, labor, and overhead contained in this inventory are priced at standard cost. It is necessary to take into consideration the **stage of completion** reached by multiplying the aggregate standard cost of the product units on hand by a fraction representing the average degree of completion. The sum of the standard costs of the ending inventory of work in process and the units finished is then subtracted from the total debits to Work in Process to determine the amount of the variances from standard cost. This amount is then transferred to a Variances from Standard account (entry 7). Any balance remaining in a service department account is also a variance from standard. The balance remaining in the Work-in-Process account is the standard cost of the ending inventory.

Another method is to arrange the **standard cost card** to show a cumulative cost from which can be read the unit standard cost incurred at the completion of each operation in the manufacturing process. Rearranging the standard cost card (Fig. 1) in this fashion, it would appear as shown in Fig. 5. The following

Balance Sheet

June 30, 19__

Assets:	
Accounts Receivable	$10,000.00
Raw Materials (actual cost)	6,304.80
Work-in-Process Inventory (standard cost)	2,270.00
Finished Goods (standard cost)	5,736.00
Total Assets	$24,310.80
Equities:	
Vouchers Payable, etc.	$13,993.50
Payroll Accrued	4,806.50
Capital Stock	3,676.00
Net Profit from Manufacturing	1,834.80
Total Equities	$24,310.80

PROFIT AND LOSS STATEMENT

Month of June, 19__

Sales	$10,000.00
Cost of Sales (standard)	7,170.00
Gross Profit from Manufacturing	$ 2,830.00
Unfavorable Variances from Standard Cost	995.20
Net Profit from Manufacturing	$ 1,834.80

SCHEDULE OF VARIANCES FROM STANDARD COST

Month of June, 19__

Material price variance	$287.20
Material usage variance	10.00
Labor rate variance	60.50
Labor usage variance	164.00
Overhead expense variance	65.75
Overhead efficiency variance	15.00
Overhead utilization variance	392.75
Total variances from standard cost	$995.20

(The amount of these variances is computed on subsequent pages.)

Fig. 7. Financial statements under partial plan when variances are not distributed.

figures illustrate the calculation of the standard cost of work-in-process inventories.

Beginning inventory of work in process:	
Department A	20 units
Department B	None
Ending inventory of work in process:	
Department A	10 units
Department B (⅔ completed in operation 3)	20 units

The 20 units in the beginning inventory of Department A have been completed in operation 1 but have not yet started operation 2. The standard cost is therefore:

20 units × \$31.50 [Fig. 5, line 1, col. (i)] = \$630.00

The ten units in the ending inventory in Department A have not yet started processing, but materials M-1 and M-2 have been issued. The standard cost of the work-in-process inventory in Department A is therefore:

10 units × \$19.00 [Fig. 5, line 1, col. (c)] = \$190.00

The work-in-process in Department B has started operation 3 and therefore has incurred all the costs of Department A plus material M-3, which is added at the start of operation 3 plus two-thirds of the operating cost of operation 3. Two-thirds of the operating cost on 20 units is the equivalent of all the operating cost on 13⅓ units (20 × ⅔). The standard cost of the work-in-process inventory in Department B is therefore:

20 units × \$70.50 [Fig. 5, line 2, col. (i)] =	\$1,410.00
20 units × \$24.00 [Fig. 5, line 3, col. (b)] =	480.00
13⅓ units × \$ 5.25 [Fig. 5, line 3, col. (d)] =	70.00
13⅓ units × \$ 9.00 [Fig. 5, line 3, col. (f)] =	120.00
	\$2,080.00

COMMON VARIATIONS UNDER PARTIAL PLAN. There are innumerable variations in the journal entries made in actual practice under the partial plan. Some of the more common are:

1. The Work-in-Process accounts may be debited with the applied overhead costs instead of actual overhead costs. In the example the amounts would be \$2,065.00 to Work-in-Process, Department A, and \$2,370.00 to Work-in-Process, Department B. These figures are calculated by multiplying the actual hours worked by the normal overhead rate. (2,065 hours × \$1.00 for Department A and 790 hours × \$3.00 for Department B.) Actual overhead costs would then be debited to an Overhead Cost account.
2. In the distribution of power costs, fixed as well as variable costs may be charged to producing departments on the basis of a standard rate. The rate in this case would be \$0.015 per kw.h. consumed, and the debits would be \$375.00 to Work-in-Process, Department A (for 25,000 kw.h.), and \$975.00 to Work-in-Process, Department B (for 65.000 kw.h.). The smaller debit to Department B as compared with the \$1,050.00 charged in entry 4 is caused by the fact that it is not charged for the idle capacity of the power department. (See discussion on Overhead Variances of Service Departments subsequently in this section.)
3. Many companies have one Work-in-Process controlling account for all departments, and other companies have separate accounts for materials in process, labor in process, and overhead in process.
4. Many companies will have separate variance accounts for the different variances. According to NAA Research Series No. 13 (NAA Bulletin, vol. 29) the number of variance accounts to have is determined by (1) the number and types of variances which are to appear in the statement of cost of goods manufactured and in the income statement, and (2) the need for separation of variances to facilitate disposal of the variance balances. The different variances are not always treated uniformly at the end of the period.

CALCULATION OF VARIANCES FROM STANDARD. The Variances from Standard account is an algebraic sum of variances flowing from a num-

ber of causes, and it is necessary to analyze the aggregate figure according to the factors responsible for each part of the variance. While this can be readily accomplished, information from sources outside the accounting records is needed. The process of analysis and the sources from which essential data can be obtained are discussed in the subsequent paragraphs.

Direct Material Cost Variances. In order to separate material price and material usage variances, it is necessary to know:

1. Actual physical usage of each material.
2. Actual cost of material used.
3. Standard physical usage of each material.
4. Standard unit cost of each material.

The first of these figures can be obtained from material consumption records or, when used, material requisitions, and the second can be obtained from the stores records or purchase records.

The formula for computing the **material price variances** is

Material price variance = actual usage × (standard unit cost − actual unit cost).

The variances for each type of material are

Material M-1:	520 × ($1.00 − $ .86) =	$ 72.80 gain
Material M-2:	200 × ($7.00 − $7.70) =	140.00 loss
Material M-3:	1,100 × ($2.00 − $2.20) =	220 00 loss
		$287.20 loss

Calculation of material usage variance calls for knowledge of the total standard quantity of materials contained in the goods produced; this figure is obtained by multiplying the equivalent physical units produced during the period by the standard usage quantities. Care must be used to include in the standard material usage figure only such materials as should have been used in bringing the unfinished product units to the stage of completion that they have reached on the closing date of the period. The formula for determining the **equivalent physical units produced** is

Equivalent physical units produced = units finished + equivalent units in ending inventory − equivalent units in beginning inventory.

The formula for determining the **standard physical usage** of each material is

Standard physical usage = standard quantity of material per unit × equivalent physical units produced.

The formula for determining the **material usage variance** is

Material usage variance = standard unit price × (standard physical usage − actual quantity of material used).

The standard physical usage of each type of material is

Material M-1:	100 + 10 − 20 =	90 equivalent physical units × 5 =	450 units
Material M-2:	100 + 10 − 20 =	90 equivalent physical units × 2 =	180 units
Material M-3:	80 + 20 − 0 =	100 equivalent physical units × 12 =	1,200 units

The material usage variance for each type is

Material M–1:	\$1.00 × (450 − 520) =	\$ 70.00 loss
Material M–2:	\$7.00 × (180 − 200) =	140.00 loss
Material M–3:	\$2.00 × (1,200 − 1,100) =	200.00 gain
		\$10.00 loss

Direct Labor Cost Variances. The required data are:

1. Actual hours of labor used.
2. Actual rate paid.
3. Standard hours contained in attained production.
4. Standard rate.

The first of these figures is obtainable from a summary of clock cards, **payroll summary**, etc., and the actual cost of this time is available in payroll records. The number of standard hours must be obtained by multiplying the equivalent production figures for the month by the **standard unit labor usage.** With unfinished units still in process, the standard quantity of labor in the product at the stage of completion reached must be used. The standard rate is taken from the standard cost card.

The formula for **labor rate variance** is

Labor rate variance = actual hours used × (standard hourly rate − actual hourly rate).

The labor rate variance figures are:

Operation 1:	525 × (\$1.50 − \$1.50) =	\$ 0.00
Operation 2:	1,540 × (\$1.60 − \$1.65) =	77.00 loss
Operation 3:	230 × (\$1.75 − \$1.80) =	11.50 loss
Operation 4:	560 × (\$1.95 − \$1.90) =	28.00 gain
		\$60.50 loss

The **labor usage variance** or **labor efficiency variance** can be obtained from the following formulas: The formula for the equivalent production is

Equivalent production = units finished + equivalent units in ending inventory − equivalent units in beginning inventory.

The formula for determining the standard labor hours is

Standard labor hours = equivalent production × standard hours per unit.

The formula for determining the labor usage or labor efficiency variance is

Labor usage variance = standard labor rate × (standard labor hours − actual labor hours).

The standard hours for each operation are:

Operation 1:	100 + 0 − 20 = 80 equivalent units × 5 =	400 hr.
Operation 2:	100 + 0 − 0 = 100 equivalent units × 15 =	1,500 hr.
Operation 3:	80 + 13⅓ − 0 = 93⅓ equivalent units × 3 =	280 hr.
Operation 4:	80 + 0 − 0 = 80 equivalent units × 7 =	560 hr.

The labor usage variance amounts are:

Operation 1:	\$1.50 × (400 − 525) =	\$187.50 loss	
Operation 2:	\$1.60 × (1,500 − 1,540) =	64.00 loss	
Operation 3:	\$1.75 × (280 − 230) =	87.50 gain	
Operation 4:	\$1.95 × (560 − 560) =	0.00	
			\$164.00 loss

Overhead Variances of Producing Departments. Overhead or manufacturing cost variances are usually of three types: (1) expense or budget variance (2) efficiency variance and (3) utilization variance.

The **expense variance** is the result of spending more or less than the budgeted allowances for indirect materials, indirect labor, etc., at the attained activity level.

The **efficiency variance,** also called **controllable** variance, is the result of using more or less than the standard amount of overhead service. It arises whenever the actual direct labor hours or machine hours differ from the standard allowed hours.

The **utilization variance,** frequently referred to as **capacity** variance, or **volume** variance, is the result of operating more or less than the normal number of hours in any given budget period.

In order to compute overhead variances, it is necessary to know:

1. Actual overhead for the period.
2. Actual number of direct labor hours (or other units, if overhead is not distributed on basis of direct labor hours).
3. Budgeted overhead for period.
4. Number of standard labor hours in product.
5. Normal overhead rate.

The sources of these data are:

1. Actual overhead is obtained by summing debits in departmental overhead accounts (departmental **cost distribution sheet**).
2. Actual number of direct labor hours is compiled from clock cards.
3. Budgeted overhead is obtained from the flexible budgets (Figs. 2 to 4) by selecting figures corresponding to the actual number of direct labor hours worked. In the case of Department A, actual hours worked are 2,065 against 2,000 normal. The budget allowance for 2,065 hours is obtained by interpolation in the flexible budget (Fig. 3). Since the variable cost per hour is \$.50, the budget for 2,065 hours is arrived at as follows:

Fixed or stand-by charges	\$1,000.00
Variable charges (2,065 × \$.50)	1,032 50
Total	\$2,032.50

   Similarly the budget for the 790 hours actually worked in Department B (Fig. 4) is as follows:

Fixed or stand-by charges	\$2,025.00
Variable charges (790 × \$.975)	770.25
Total	\$2,795.25

4. The number of standard direct labor hours in production is found by multiplying the units produced by the standard labor hour content per unit as shown by the standard cost card.
5. The normal overhead rate is obtained from the standard cost card.

The formulas for the overhead variances are:

1. Overhead expense or budget variance = (budgeted overhead cost at actual activity level) − (actual overhead cost).

2. Overhead efficiency variance = (normal overhead rate × standard direct labor hours in product) − (normal overhead rate × actual direct labor hours in product).

3. Overhead utilization variance = (normal overhead rate × actual direct labor hours in product) − (budgeted overhead cost at actual activity level).

These formulas yield the following variance figures:

Department A:		
Expense variance	= \$2,032.50 − \$2,011.00 =	\$ 21.50 gain
Efficiency variance	= \$1.00 (1,900 − 2,065) =	165.00 loss
Utilization variance	= \$2,065.00 − \$2,032 50 =	32.50 gain
Department B:		
Expense variance	= \$2,795.25 − \$2,870.00 =	\$ 74.75 loss
Efficiency variance	= \$3.00 (840 − 790) =	150.00 gain
Utilization variance	= \$2,370.00 − \$2,795.25 =	425.25 loss

For other methods of computing overhead variances, see section on Analysis and Control of Standard Cost Variations.

Overhead Variances of Service Departments. As a first step in obtaining a variance for service departments, it is necessary to make service department cost distributions. The **power cost distribution** illustrated here is typical.

Department A (Fig. 3) requires, when operating at normal capacity, 25,000 kw.h. of power monthly, and Department B (Fig. 4) requires, at normal capacity, 75,000 kw.h. monthly. Hence, Department A is responsible for one-fourth of power plant capacity, and Department B for three-fourths. **Fixed costs** of the power plant, which represent **stand-by costs** of providing this capacity to supply 100,000 kw.h. per month, are therefore distributed to the two productive departments in proportion to these capacity figures. The fixed power cost distribution based on the flexible budget (Fig. 2) is:

To Department A:	¼ × \$750.00 = \$187.50	
To Department B:	¾ × 750.00 = 562 50	\$750.00

Variable costs of generating power are charged to producing departments at a standard unit rate determined by dividing total budgeted variable power costs at normal capacity (\$1,500 − \$750) by the number of kilowatt-hours generated when the power plant is operating at normal capacity (100,000). The calculations are:

$$\$750.00 \div 100{,}000 = \$.0075 \text{ per kw.h.}$$

This serves to distribute the variable costs of generating power to the producing departments in the ratio of actual power consumption as follows:

To Department A:	\$.0075 × 25,000 = \$187.50	
To Department B:	.0075 × 75,000 = 562.50	\$750.00

This double basis of power cost distribution is advocated by Schlatter and Schlatter (Cost Accounting) who contend that fixed power costs should be apportioned on the basis of consumption of current at normal capacity (i.e., capacity ratios), while variable power costs are to be distributed on the basis of actual consumption (consumption ratios). In this way a fairer service cost distribution results when actual operations are more or less than normal capacity.

The power plant has spent $12.50 more than its budget allowance for the month, and hence there is an **expense variance** of this amount chargeable to the power plant. While only 90% of the power plant's normal capacity has been used, no **utilization variance** appears in the power plant accounts because all fixed costs pertaining to it have been distributed to producing departments. Hence idleness in the power plant increases the utilization variance of producing departments, in this case Department B, since Department A operated at slightly above normal capacity.

SUMMARY OF OVERHEAD VARIANCES

	Department A	Department B	Power	Total
Expense	($ 21.50)	$ 74.75	$12.50	$ 65 75
Efficiency	165.00	(150.00)	—	15.00
Utilization	(32.50)	425.25	—	392 75
Total	$111.00	$350.00	$12.50	$473 50

(For other methods of computing variances, see section on Analysis and Control of Standard Cost Variances.)

DISPOSITION OF VARIANCES UNDER PARTIAL PLAN. The ultimate disposal of the cost variances from standard is a matter concerning which different lines of opinion exist. In general the method advocated is determined by the accountant's attitude toward standard costs. The methods in use and the reasons advanced in support of each are summarized below:

1. Close to Profit and Loss.
2. Distribute to inventories and Cost of Sales, or Cost of Sales only.
3. Close out to reserve accounts.

The first two methods are both illustrated in the journal entries. Apparently both are acceptable to the independent auditors. Accounting Research Bulletin No. 43 (American Institute of Certified Public Accountants) states with regard to the valuation of inventories:

> Standard costs are acceptable if adjusted at reasonable intervals to reflect current conditions so that at the balance sheet date standard costs reasonably approximate costs computed under one of the recognized bases. In such cases descriptive language should be used which will express this relationship, as, for instance, "approximate costs determined on the first-in, first-out basis," or, if it is desired to mention standard costs, "at standard costs, approximating average costs."

Many companies will distribute some of the variances and close others to Profit and Loss. The **materials price variance** is the one most frequently distributed, since it is often large in amount and is for the most part uncontrollable. The **overhead utilization** (volume) and **expense variances** (budget) are the ones most commonly closed to Profit and Loss, since they represent unabsorbed overhead which is usually closed to Profit and Loss even when standard costs are not used.

Closing Variances to Profit and Loss. Those who favor this method present the following arguments:

1. The standard cost represents the proper or justifiable cost of goods manufactured. This view is expressed in Matz–Curry–Frank (Cost Accounting):

> . . . Only standard costs should be considered the real or true costs. Any variance is not an increase or decrease in manufacturing costs but rather a deviation from contemplated costs. Deviations or variances are merely the results of abnormal inactivity, extravagance, inefficiences or efficiencies, or other vicissitudes of business fortune. This viewpoint leads to the statement that all variances, debits or credits, should be charged or credited to the income and expense account at the end of the month or at the end of the fiscal period. On the income statement, therefore, the variances are listed separately below the standard cost of sales to indicate what they are and to permit further analysis without reorganizing any figures.

Many proponents, however, would agree that this argument does not hold for uncontrollable variances, especially variances caused by price changes occurring after the date the standards were set.

2. Standard costs provide **inventory valuations** that are conservative, for they do not include in inventory figures the cost of wastes, losses, inefficiencies, and excessive overhead from low volume of production. If the standards are normal costs, the effect of **cyclical price swings** is likewise removed to a considerable extent, and, compared with the valuation determined by actual cost methods, the inventory is valued at a lower figure in times of inflationary prosperity and at a higher figure in times of extreme depression.

3. Standard costs make **statements** available at an earlier date because inventory valuations are easier to obtain at standard cost than at actual cost

4. Gross profit margin as a measure of merchandising activities is more readily comparable from month to month when variations in manufacturing cost are excluded from it by entering only standard costs in the Cost of Goods Sold account.

5. Executives are more certain to notice variances and to take action to prevent their recurrence when these variances are set out in the profit and loss statement as losses or gains. On the other hand, the need for **managerial action** is obscured when variances are combined with cost of goods manufactured or when they are set up as reserves.

6. In a plant where many different products are manufactured, it may be very difficult to determine accurately how much variance should be distributed to each product.

Distribution of Variances. By distributing variances over inventories and cost of goods sold, both these items are shown at actual cost in the financial statements. While variances are kept in separate ledger accounts, these accounts are regarded as valuation accounts to be closed into inventory and Cost of Goods Sold accounts when the financial statements are prepared. In support of this procedure, the following reasons are given frequently:

1. Only **actual costs** should be admitted to the financial statements. The basis for this opinion seems to be an unwillingness to recognize standard costs as **true costs,** for standard costs are viewed merely as convenient aids to factory management and not as costs suitable for use in the income statement. On the other hand, actual costs are regarded as facts, and as such it is felt that they should be used in the financial statements, regardless of their effect. It could also be argued that the public at large is unfamiliar with standard costs and is unable to understand statements containing them. However, published statements have long

reported inventories and cost of sales figures in which overhead is included at a standard rate.

2. Variances from standard costs are not losses but costs and hence should be reflected in inventory valuations. Furthermore, charging off variances in the period in which they arise distorts the net profit figures.

3. Standards must be accurate and reliable if they are to serve as the basis for inventory values in the balance sheet. During the developmental stage and before their accuracy has been tested, it is doubtless best to use actual costs for financial statement purposes.

A variation of the method of distributing variances is to close them to Cost of Sales. If it is done for all variances, it has the effect of converting the standard cost of sales into an actual cost of sales. Although the method is attractive because of its simplicity, on theoretical grounds it cannot easily be defended. Thus, according to Schlatter and Schlatter (Cost Accounting) if the variances represent actual cost of goods, they relate to inventories as well as to the goods sold. If they represent real losses or gains, they cannot be cost of goods whether sold or unsold.

The Committee on Accounting Concepts and Standards of the American Accounting Association (Accounting and Reporting Standards for Corporate Financial Statements) observes that standard costs "typically are adjusted to historical outlay cost in published financial reports."

Calculation of Amounts To Be Distributed. If we use the figures in the preceding illustration, the ending inventory balances and Cost of Sales will contain the following amounts and percentages of the various cost elements:

	Materials		Labor		Overhead	
	Amount	Percent	Amount	Percent	Amount	Percent
Work in Process, Dept. A.	$ 190 00	3 862				
Work in Process, Dept. B.	860.00	17.480	$ 700.00	13.369	$ 520.00	10.358
Finished Goods	1,720.00	34 959	2,016 00	38 503	2,000.00	39.841
Cost of Sales	2,150 00	43.699	2,520.00	48.128	2,500.00	49.801
	$4,920 00	100 000	$5,236.00	100 000	$5,020 00	100 000

The above amounts are obtained by multiplying the number of units in each category by the standard material, labor, and overhead costs per unit. The variations would then be allocated on the basis of these percentages as follows:

	Materials	Labor	Overhead	Total
Work in Process, Dept. A	$ 11.48	$ 0.00	$ 0 00	$ 11.48
Work in Process, Dept. B	51.95	30 01	49.04	131.00
Finished Goods	103.90	86.44	188 65	378.99
Cost of Sales	129.87	108.05	235.81	473.73
	$297 20	$224 50	$473.50	$995.20

The closing entries which would be made when the variations were distributed have been shown prior to this as entry 9b (see preceding text under Journal Entries for Partial Plan), and the financial statements are shown in Fig. 8.

There will normally be some **beginning balances** in the variance accounts which represent the portion of the previous period's variances which were distributed to the ending inventories of that period. These amounts will be distributed along with the variances of the current period.

In the preceding example, the standard costs have been adjusted to actual cost on an **average cost** basis. According to Anderson (Practical Controllership)

BALANCE SHEET

June 30, 19__

Assets:	
Accounts Receivable	$10,000.00
Raw Materials (average cost)	6,304.80
Work-in-Process Inventory (average cost)	2,412.48
Finished Goods (average cost)	6,114.99
Total Assets	$24,832.27
Equities:	
Vouchers Payable, etc.	$13,993.50
Payroll Accrued	4,806.50
Capital Stock	3,676.00
Net Profit from Manufacturing	2,356.27
Total Equities	$24,832.27

PROFIT AND LOSS STATEMENT

Month of June, 19__

Sales	$10,000.00
Cost of Sales (actual)	7,643.73
Gross Profit from Manufacturing	$ 2,356.27

Fig. 8. Financial statements under partial plan when variances are distributed.

the adjustment to actual cost may also be made on a **last-in, first-out (lifo)** or **first-in, first-out (fifo)** basis, either by individual materials or by classes of material. The standard value of each material in the inventory may be individually adjusted to actual cost on a last-in, first-out or first in, first-out basis, and the remainder of the materials price variance may be closed to Cost of Sales. Where this is impractical, the various materials may be classified into groups, and the ratio of actual to standard cost by group may be determined for the purchases of each month. These ratios may then be used to adjust the inventories from standard cost to actual cost, using the ratios for the last month or months of the fiscal year for first-in, first-out or the ratios of the first month or months of the fiscal year if last-in, first-out is to be used.

Variance Reserves. Under this method, variance gains are carried as **deferred credits** until offset by variance losses, and variance losses are carried as **deferred charges** until offset by variance gains. The preponderant weight of opinion is against carrying such balances beyond the end of the fiscal year. **Seasonal fluctuations,** however, may follow a regular and recurrent cycle within a year, and hence the plan of deferring utilization variance balances during a seasonal cycle is workable and appears to be fairly widely used. **Utilization balances** resulting from seasonality in the use of plant should, over a complete seasonal cycle, cancel out, and any amount remaining at the end of a year should then be written off.

Inventory Valuation and Variances. Inventories which have been costed at standard cost are subject to the usual adjustments for spoilage, obsolescence and deterioration, and realizable value. According to NAA Research Series No. 13 (NAA Bulletin, vol. 29), where the common practice of valuing inventories at **the lower of two prices, cost or market,** is followed, the use of standard costs

does not offer any new problems. The test of a comparison with market prices can be applied to standard costs just as readily as to actual costs. If the inventory is found to be materially above the market, it may be written down whether it be carried at standard or actual cost.

Even those who object to a standard cost basis of valuing labor and materials in inventory generally apply a **standard overhead rate** if the business is subject to marked fluctuations in output. From a historical point of view, objections to the use of standard costs for inventory valuation seem to have been discarded one by one. Thus the early writers on accounting objected to any inclusion of overhead in costs on the ground that advance estimates created arbitrary and fictitious inventory debits. Today practically all cost systems purporting to give actual costs make use of a predetermined burden rate. In fact so common is the practice that most people now think of actual cost as meaning actual material, actual labor, and normal overhead. Valuation of direct materials and direct labor at standard cost is thus but a step farther in the same direction in which accounting has been moving for a long time, rather than a sudden break from an actual to a standard cost basis of calculating figures to serve as a basis for financial statements.

JOURNAL ENTRIES FOR REVISION OF STANDARDS. A change in standards raises the question as to whether or not to adjust the closing inventory for such changes. According to NAA Research Series No. 13 (NAA Bulletin, vol. 29) there are two answers to the question, as follows:

1. If the new standard costs reflect conditions which affected the actual cost of the goods in the closing inventory, most companies adjust the inventory to the new standard cost and carry the contra side of the adjusting entry to cost of sales by way of the variance accounts. In effect, this procedure assumes that the standard costs used to cost goods in the inventory have been incorrect and that restatement of inventory cost is needed to bring inventories to a correct figure on the books. Since the use of incorrect standards has affected the variance accounts as well as the inventory, the adjustment is carried to the variance accounts.
2. If the standard costs represent conditions which are expected to prevail in the coming period but which have not affected costs in the past period, closing inventories are costed at the old standards. It appears to be common practice to adjust the detailed inventory records to new standard costs before the end of the year just passed. In order to maintain the control relationship which the inventory accounts have over subsidiary records, the same adjustment is entered in the inventory control accounts and the contra entry is carried to an inventory valuation account. Thus the net effect is to state the inventory in the closing balance sheet at old standard costs. In the next period the inventory valuation account is closed to cost of sales when the goods to which the reserve relates move out of inventories. By use of this technique the detailed records can be adjusted to new standards before the beginning of the year while at the same time the net charge to cost of sales in the new period is for old standard cost since the latter cost was correct at the time the goods were acquired.

Accounting for Single Plan

Charging Work in Process at Standard Cost

CHARACTERISTICS OF SINGLE PLAN. The distinctive features of the single plan are:

1. Both debits and credits to Work in Process are entered at standard cost, and the Finished Goods and Cost of Sales accounts are also carried at standard cost. Bennett (Standard Costs, How They Serve Modern Management) favors this as the most logical of the several procedures possible.

2. Most companies also carry the raw materials inventory at standard cost, although some carry it at actual cost. NAA Research Series No. 13 (NAA Bulletin, vol. 29) states that in approximately three-fourths of the companies included in the NAA field study, raw materials were carried on the books at standard cost. There are also companies which carry some items, usually supplies to be charged to overhead accounts, at actual cost and the remainder at standard cost.
3. Variances are usually accumulated during the accounting period from material requisitions and time tickets by the input method (see Methods for Determining Variations from Standard in this section). This method makes it possible to analyze variations daily or weekly if desired.

ILLUSTRATION OF SINGLE PLAN. The facts assumed are the same in amount as those assumed for the **partial plan,** to facilitate comparison between the two methods. The data for direct material and direct labor, however, are restated in the form in which they would be obtained by the input method. All other facts are the same as under the partial plan discussed in this section.

Restatement of Transactions for Direct Material and Direct Labor. The transactions for direct material and direct labor can be restated as follows:

1. Material purchases per invoices:

Kind	Actual Price	Standard Price	Variance
M–1	$ 850	$1,000	$150 gain
M–2	3,850	3,500	350 loss
M–3	4,400	4,000	400 loss
	$9,100	$8,500	$600 loss

2. Materials put into process per material requisitions:

	Dept. A	Dept. B	Total
Standard material requisitions	$1,710.00	$2,400.00	$4,110.00
Excess material requisitions	210.00	....	210.00
Material saved credit memos		200.00	200.00

3. Direct labor used per time tickets:
   a. Amounts

	Standard Hours at Standard Rates	Actual Hours at Standard Rates	Actual Hours at Actual Rates
Operation 1	$ 600.00	$ 787.50	$ 787.50
Operation 2	2,400 00	2,464 00	2,541.00
Operation 3	490.00	402.50	414.00
Operation 4	1,092.00	1,092.00	1,064.00
Totals	$4,582.00	$4,746.00	$4,806.50

   b. Hours

	Standard Hours	Actual Hours
Operation 1	400	525
Operation 2	1,500	1,540
Dept. A Total	1,900	2,065
Operation 3	280	230
Operation 4	560	560
Dept. B. Total	840	790
Grand Total	2,740	2,855

4. All overhead figures to be obtained in the same way as under the partial plan, as shown earlier in this section.

5. Standard cost of goods finished per production records: $11,472.00 (80 units × $143.40, per Fig. 1).

6. Sales and cost of sales per sales invoices and stores ledger:

   a. Standard cost of goods sold: $7,170.00 (50 units × $143.40).

   b. Sales value of goods sold: $10,000.00 (50 units × $200.00).

Journal Entries for Single Plan. The journal entries for this method are shown here, followed by explanations of the entries and figures. The latter are carried through to the variance calculations, the ledger accounts (Fig. 9), and the financial statements (Fig. 10).

1. Entry for raw materials purchased:

Raw Materials	$8,500.00	
Materials Price Variance	600.00	
Vouchers Payable, etc.		$9,100.00
To charge Raw Materials account with the standard cost of materials purchased.		

2. Entry for direct material put into process:

Materials in Process	$4,110.00	
Materials Usage Variance	10.00	
Raw Materials		$4,120.00
To charge Material in Process account with the standard cost of the standard quantity of material used (see Fig. 7 for variances).		

3. Entry for direct labor cost incurred:

Labor in Process	$4,582.00	
Labor Usage Variance	164.00	
Labor Rate Variance	60.50	
Payroll		$4,806.50
To charge Labor in Process account with the standard cost of the standard quantity of labor (see Fig. 7 for variances).		

4. Entry for actual overhead costs:

Overhead Cost	$4,893.50	
Vouchers Payable, etc.		$4,893.50
To charge Overhead Cost account with the actual overhead costs for the period (see prior entries 4a and 4c for Partial Plan). Separate overhead accounts for Power, Department A, and Department B might also be used.		

5. Entry for overhead applied:

Overhead in Process	$4,420.00	
Overhead Efficiency Variance	15.00	
Overhead Cost, Applied		$4,435.00
To charge Overhead in Process with standard overhead cost, determined by multiplying the standard hours by the normal overhead rates (see Fig. 7 for variances).		

6. Entry to set up other overhead variances:

Overhead Cost, Applied	$4,435.00	
Overhead Expense Variance	65.75	
Overhead Utilization Variance	392.75	
Overhead Cost		$4,893.50
To set up the remaining overhead variances and to close out the overhead accounts (see Fig. 7 for variances).		

Raw Materials

Bal.	$ 1,500.00	(2)	$ 4,120.00
(1)	8,500.00	Bal.	5,880.00
	$10,000.00		$10,000.00
Bal.	$ 5,880.00		

Materials in Process

Bal.	$ 380.00	(7)	$ 3,440.00
	4,110.00	Bal.	1,050.00
	$ 4,490.00		$ 4,490.00
Bal.	$ 1,050.00		

Labor in Process

Bal.	$ 150.00	(7)	$ 4,032.00
(3)	4,582.00	Bal.	700.00
	$ 4,732.00		$ 4,732.00
Bal.	$ 700.00		

Overhead in Process

Bal.	$ 100.00	(7)	$ 4,000.00
(5)	4,420.00	Bal.	520.00
	$ 4,520.00		$ 4,520.00
Bal.	$ 520.00		

Overhead Cost

(4)	$ 4,893.50	(6)	$ 4,893.00

Overhead Cost-Applied

(6)	$ 4,435.00	(5)	$ 4,435.00

Finished Goods

Bal.	$ 1,434.00	(8b)	$ 7,170.00
(7)	11,472.00	Bal.	5,736.00
	$12,906.00		$12,906.00
Bal.	$ 5,736.00		

Cost of Sales

(8b)	$ 7,170.00	(9)P&L	$ 7,170.00

Accounts Receivable

(8a)	$10,000.00		

Sales

(9)P&L	$10,000.00	(8a)	$10,000.00

Payroll

		(3)	$ 4,806.50

Vouchers Payable, etc.

Bal.	$13,993.50	(1)	$ 9,100.00
		(4)	4,893.50
	$13,993.50		$13,993.50
		Bal.	$13,993.50

Materials Price Variance

(1)	$ 600.00	(9)P&L	$ 600.00

Materials Usage Variance

(2)	$ 10.00	(9)P&L	$ 10.00

Labor Rate Variance

(3)	$ 60.50	(9)P&L	$ 60.50

Labor Usage Variance

(3)	$ 164.00	(9)P&L	$ 164.00

Overhead Efficiency Variance

(5)	$ 15.00	(9)P&L	$ 15.00

Overhead Expense Variance

(6)	$ 65.75	(9)P&L	$ 65.75

Overhead Utilization Variance

(6)	$ 392.75	(9)P&L	$ 392.75

Profit and Loss

		(9)	$ 1,522.00

Capital Stock

		Bal.	$ 3,564.00

Capital Stock in an amount just equal to the beginning inventories was assumed so that the ledger would balance. Note that since the beginning inventory of Raw Materials is carried at standard cost under the single plan, the amount required to balance is different from that under the partial plan (Fig. 6).

Fig. 9. Ledger accounts for single plan standard costs.

Balance Sheet

June 30, 19__

Assets:	
Accounts Receivable	$10,000.00
Raw Materials (standard cost)	5,880.00
Work in Process (standard cost)	2,270.00
Finished Goods (standard cost)	5,736.00
Total Assets	$23,886.00
Equities:	
Vouchers Payable, etc.	$13,993.50
Payroll Accrued	4,806.50
Capital Stock	3,564.00
Net Profit from Manufacturing	1,522.00
	$23,886.00

PROFIT AND LOSS STATEMENT

Month of June, 19__

Sales	$10,000 00
Cost of Sales (standard)	7,170 00
Gross Profit from Manufacturing	$ 2,830 00
Unfavorable Variances from Standard Cost	1,308.00
Net Profit from Manufacturing	$ 1,522.00

SCHEDULE OF VARIANCES FROM STANDARD COST

Month of June, 19__

Materials Price Variance	$ 600.00
Materials Usage Variance	10.00
Labor Rate Variance	60.50
Labor Usage Variance	164.00
Overhead Expense Variance	65.75
Overhead Efficiency Variance	15 00
Overhead Utilization Variance	392 75
Total Variances from Standard Cost	$1,308 00

Fig. 10. Financial statements under single plan.

7. Entry for work completed during the month:

Finished Goods	$11,472 00	
Materials in Process		$3,440.00
Labor in Process		4,032 00
Overhead in Process		1,000 00

To record the transfer of the goods finished during the period.

8. Entries for sales (same as entry 6 under partial plan):
a. Recording selling price—

Accounts Receivable	$10,000 00	
Sales		$10,000.00

To record sales for period.

b. Recording cost price—

Cost of Sales	$7,170.00	
Finished Goods		$7,170.00

To transfer the standard cost of goods sold from finished goods.

9. Entry to close expense and revenue accounts:

Sales	$10.000 00	
Cost of Sales		$7,170.00
Materials Price Variance		600.00
Materials Usage Variance		10.00
Labor Rate Variance		60.50
Labor Usage Variance		164.00
Overhead Efficiency Variance		15 00
Overhead Expense Variance		65.75
Overhead Utilization Variance		392.75
Profit and Loss		1,522.00

To close expense and revenue accounts. Fig. 10 shows the **financial statements** that would be drawn up after making the above journal entries.

10. **Alternative entries** to allocate variances and close expense and revenue accounts. These are not posted to the ledger illustrated in Fig. 9.

a. Prorating materials price variance:

Raw Materials	$ 387 28	
Materials in Process	69.16	
Materials Usage Variance	.66	
Finished Goods	113 29	
Cost of Sales	141.61	
Materials Price Variance		$ 712.00

To prorate the materials price variance. The amount is larger than in entry (1) of this example because if this alternative method were used, the Materials Price Variance account would have had an opening balance equal to the difference between the actual and standard cost of the beginning inventory of raw materials. (Beginning inventory actual cost of $1,612 — standard cost of $1,500 = $112 plus $600 unfavorable variance on purchases of this period = $712.) Computations are shown subsequently under Disposition of Variances under Single Plan

b. Prorating other variances from standard:

Materials in Process	$ 2.27	
Labor in Process	30.01	
Overhead in Process	49.04	
Finished Goods	278.82	
Cost of Sales	348.52	
Materials Usage Variance		$ 10.66
Labor Rate Variance		60.50
Labor Usage Variance		164.00
Overhead Efficiency Variance		15.00
Overhead Expense Variance		65.75
Overhead Utilization Variance		392.75

To prorate other variations from standard. Computations are shown subsequently under Disposition of Variances under Single Plan.

c. Closing expense and revenue accounts (these entries are not posted to the ledger illustrated in Fig. 9):

Sales	$10,000.00	
Cost of Sales		$7,660.16
Profit and Loss		2,339.84
To close expense and revenue accounts.		

d. Reversing proration of materials price variance:

Materials Price Variance	$ 570.39	
Raw Materials		$ 387.28
Materials in Process		69.16
Materials Usage Variance		.66
Finished Goods		113.29
To readjust beginning inventories of the new period to standard material prices.		

e. Reversing proration of other variances:

Materials Usage Variance	$ 6.00	
Labor Rate Variance	31.38	
Labor Usage Variance	85.07	
Overhead Efficiency Variance	7.53	
Overhead Expense Variance	33.01	
Overhead Utilization Variance	197.15	
Materials in Process		$ 2.27
Labor in Process		30.01
Overhead in Process		49.04
Finished Goods		278.82
To readjust beginning inventories of new period to standard cost.		

Methods of Handling Materials Price Variances Under Single Plan. There are three methods of recording materials price variances under the single plan. These are illustrated in Fig. 11:

1. The Raw Materials account may be kept at standard cost and the price variances separated at the time of purchase (as is done in the illustration of the single plan).
2. The Raw Materials account may be kept at actual cost and the price variances separated at the time of use.
3. A compromise method may be used whereby the Raw Materials account is kept at standard cost and a **materials price suspense** account is set up at the time of purchase. When materials are issued, the suspense account is adjusted by transferring the part of the price variance which applies to those materials to a materials price variance account. Thus the same price variance is obtained as under the first method. On the balance sheet the compromise method works out as follows:

Raw Materials Inventory	$2,000.00	
Materials Price Suspense	1,000.00	$3,000.00

The net effect is the same as when the price variance is recorded at the time of issue.

In Fig. 11 a high variance percent is used to make the distinction between Method II and Methods I and III stand out.

Fig. 12 is an illustration of the actual procedure involved in computing and segregating material price variances at the time of purchase. Forms A and B on

I. Price Variance at Time of Purchase

(1)

Raw Materials	$3,000	
Materials Price Variance . .	1,500	
Accounts Payable		$4,500

To record purchase of 3,000 units at standard cost of $1.00 each

(2)

Work in Process	1,000	
Raw Materials		1,000

To record issuance of 1,000 units at $1.00 standard cost

Raw Materials

(1) Std.	$3,000	(2) Std.	$1,000
		Bal.(Std.)	2,000
	$3,000		3,000

Work in Process

(2) Std.	$1,000		

Materials Price Variance

(1)	$1,500		

II. Price Variance at Time of Issue

(1)

Raw Materials	$4,500	
Accounts Payable		$4,500

To record purchase of 3,000 units at $1.50 actual cost

(2)

Work in Process	1,000	
Materials Price Variance . .	500	
Raw Materials		1,500

To record issuance of 1,000 units at $1.00 standard cost

Raw Materials

(1) Act.	$4,500	(2) Act.	$1,500
		Bal.(Act.)	3,000
	$4,500		$4,500

Work in Process

(2) Std.	$1,000		

Material Price Variance

(2)	$ 500		

III. Price Variance at Purchase and Issue

(1)

Raw Materials	$3,000	
Materials Price Suspense . .	1,500	
Accounts Payable		$4,500

To record purchase of 3,000 units at standard cost, charging price variance to a suspense account

(2)

Work in Process	1,000	
Raw Materials		1,000

To record issuance of 1,000 units at $1.00 standard cost

(3)

Materials Price Variance . .	500	
Materials Price Suspense .		500

To relieve suspense account of the price variance on 1,000 units issued at $.50 each

Raw Materials

(1) Std.	$3,000	(2) Std.	$1,000
		Bal.(Std.)	2,000
	$3,000		$3,000

Work in Process

(2) Std.	$1,000		

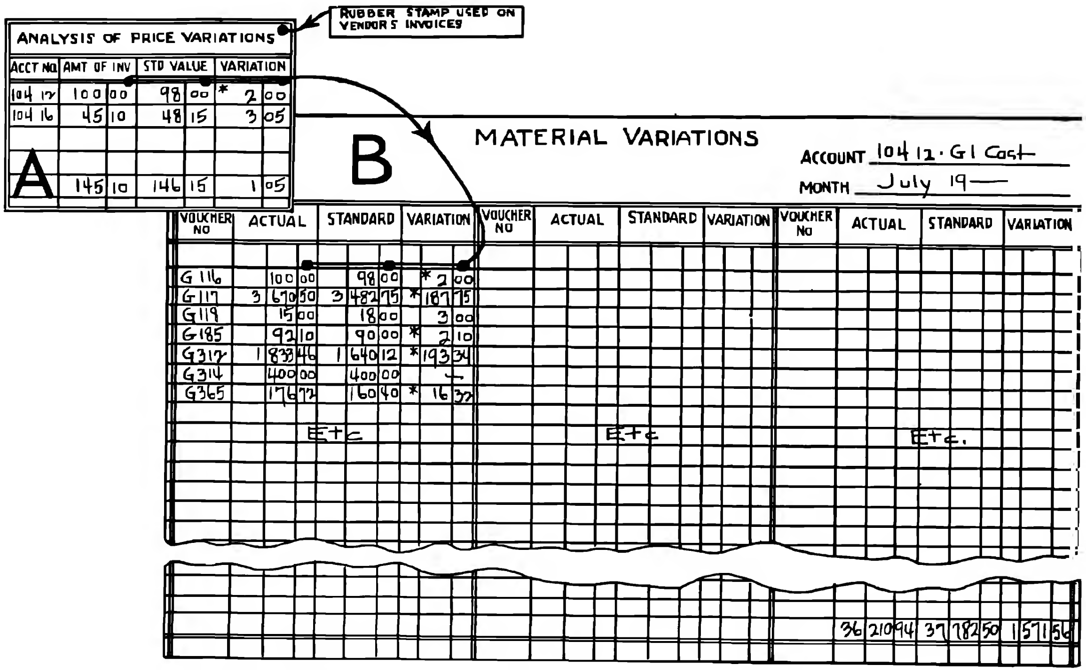
Materials Price Suspense

(1)	$1,500	(3)	$ 500
		Bal.	1,000
	$1,500		$1,500

Materials Price Variance

(3)	$ 500		

Fig. 11. Methods for handling materials price variances.



* Indicates increase in cost over standard

Fig. 12. Materials price variances (obtained at time of purchase).

Fig. 12 illustrate the recording of values at actual cost, standard cost, and the variance between the two. The vendor's invoices at time of audit for the correctness of billing detail are stamped with an analysis block such as that illustrated by form A. After audit and vouchering, the vendor's invoices are recorded by the cost department on a form such as B, materials variations (Fig. 12). Monthly totals of actual charges are controlled by the total charges to the raw material inventory accounts in the voucher register.

Materials Inventories at Standard vs. Actual. The following comments on the relative merits of carrying raw materials inventories at standard cost and actual cost are adapted from Henrici (Standard Costs for Manufacturing):

1. Carrying materials at standard greatly expedites pricing requisitions, since all will be issued at the same price. This factor is partially offset by the fact that invoices must be priced at both actual and standard cost, but there will normally be many more requisitions than invoices.
2. The stores ledger cards may be kept in quantities only when materials are carried at standard. The standard price is entered at the top of each stores ledger card, and no columns are needed for prices, thus saving considerable clerical work. Items (1) and (2) apply to goods returned to stores as well as materials purchased.
3. When the materials inventory is carried at standard, the price variance is revealed at the time of purchase rather than at the time of use. Thus the variance is called to the attention of management at an earlier date.
4. Elimination of actual prices from the stores ledger does away with a valuable source of information on current material prices. Current price figures, however, can be added easily to the cards as supplementary information.
5. There is some objection on the part of accountants to carrying the raw materials inventory at an "artificial" value. The work in process and finished goods inventories, however, will also be at standard in any event. If materials are purchased at less than standard, there is a price variance gain. This could have two results which run contrary to accepted accounting conventions: (1) The inventory would be shown on the balance sheet at a figure higher than actual cost or market, and (2) if the variance was closed directly to the profit and loss account, an unrealized gain would be shown in the income statement for the period. This can be avoided by distributing the variance to the inventory and Cost of Sales accounts as described under Disposition of Variances Under Single Plan or by the suspense account illustrated in Fig 11.
6. When materials are carried at standard, a revision of standard prices makes it necessary to recalculate the value of the entire inventory.

Henrici concludes that the advantages of carrying materials inventories at standard cost outweighed the disadvantages.

OTHER COMMON VARIATIONS UNDER SINGLE PLAN. There are innumerable variations in the journal entries made in actual practice under the single plan. Some of the more common are:

1. A separate Work-in-Process account may be used for each department, and the flow of work from department to department may be recorded as in the illustration of the partial plan. This method is satisfactory only if all work flows through the various departments in the same sequence.
2. A separate Overhead Cost account may be used for each producing and service department, and a separate Overhead Applied account may be used for each producing department.
3. Separate accounts are not always kept for each variance from standard. The factors to consider in deciding how many accounts to have are discussed under Common Variations Under Partial Plan, in this section.

CALCULATION OF VARIANCES FROM STANDARD. With the exception of the materials price variance, the amounts of the variances from standard for the single plan are the same as for the partial plan because the same figures have been assumed. Since the input method of obtaining figures is assumed for the single plan, however, the method of calculation of these amounts is different for direct material and direct labor.

Direct Materials Cost Variances. The **materials price variance** amount can be obtained directly from the purchase invoices if the Raw Materials account is kept at standard. Each invoice is priced at both actual and standard cost, and the difference between these two amounts is the price variance; in the above illustration of the single plan the amount is $600.00. If the Raw Materials account is to be kept at actual cost, the material price variance would be obtained from the material requisitions, which would then have to be priced at both actual and standard cost.

According to Lang–McFarland–Schiff (Cost Accounting), the most common way for obtaining the **materials usage variance** is to prepare a requisition for the standard quantity of materials needed to complete a given order. If additional materials are needed to complete the order, an **excess material requisition** must be prepared. If all the standard quantity of materials is not needed, the excess is returned to the storeroom and a **materials-saved credit memo** issued. The net total of these two kinds of forms will be the materials usage variance; in the above illustration the amount is $10.00.

Direct Labor Cost Variances. Both labor rate and labor usage variances are obtained from the time tickets. According to Specthrie (Basic Cost Accounting), the standard rate and time and the actual rate and time are entered on each time ticket. Extensions of actual hours times actual rate are then made on each time ticket, as well as standard hours times standard rate, and actual hours times standard rate. The formula for computing the **labor rate variance** is as follows:

Labor rate variance = (actual hours × standard rate) − (actual hours × actual rate).

The labor rate variance amounts are:

Operation 1:	\$ 787.50 − \$ 787.50 = \$ 0 00	
Operation 2:	\$2,464 00 − \$2,541.00 = \$77.00 loss	
Operation 3:	\$ 402.50 − \$ 414.00 = \$11.50 loss	
Operation 4:	\$1,092.00 − \$1,064.00 = \$28.00 gain	
		\$60.50 loss

The formula for computing the **labor usage variance** is as follows:

Labor usage variance = (standard hours × standard rate) − (actual hours × standard rate)

The labor usage variance amounts are:

Operation 1:	\$ 600.00 − \$ 787.50 = \$187.50 loss	
Operation 2:	\$2,400 00 − \$2,464.00 = \$ 64.00 loss	
Operation 3:	\$ 490.00 − \$ 402.50 = \$ 87.50 gain	
Operation 4:	\$1,092.00 − \$1,092.00 = \$ 0.00	
		\$164.00 loss

Overhead Variances. Overhead variances are computed in exactly the same way as discussed earlier under the partial plan.

Material and Labor Substitutions. In companies making many products and having a variety of multi-purpose machines, it is sometimes necessary for one reason or another to substitute a grade or kind of material or a manufacturing operation different from those specified by the standard cost cards. Gillespie (Accounting Procedure for Standard Costs) suggests that where it is necessary to substitute materials, a **substitution of materials form** be filled out, showing the standard quantity and standard price of the standard material, the quantity and standard price of the substitute material, and the dollar amount of the difference between the two. These substitution forms are requisitions which are honored by the stores department. Periodically these forms are summarized and recorded by the following entry:

Materials in Process	$xx	
Substitution of Materials Variance	xx	
Materials		$xx
To record the summary of the substitution of material forms.		

Henrici (Standard Costs for Manufacturing) suggests two possible methods of handling **labor substitutions**. One method requires the timekeeper to use a special time ticket whenever a nonstandard operation is performed. These time tickets, which should have some sort of distinguishing mark such as a color stripe, are used to determine the difference between the cost of the standard operation and the operation substituted. This method can be used when the timekeepers are alert enough to detect all substitutions. The second method, which requires considerably more clerical cost, involves computation of the total standard costs for the period on the basis of **output** as well as **input** (see discussion under Methods for Determining Variances from Standard in this section). When nonstandard operations are performed, the totals differ by the amount of the excess cost of these operations, since the time tickets used for the input method cover the substituted operations. The excess cost of nonstandard operations should be charged to a **Nonstandard Operation Variance** account.

Spoilage Losses. The spoilage of partially completed units presents a special problem when the spoiled units cannot be repaired and when the **input method** is used. The in-process accounts will have been charged with the standard cost of the material, labor, and overhead used prior to the point of spoilage. According to Gillespie (Accounting Procedure for Standard Costs) these amounts should be entered on a **spoiled work report** and removed from the accounts by the following entries:

1. Spoiled Work Variance	$xx	
Materials in Process		$xx
Labor in Process		xx
Overhead in Process		xx
To credit work in process with the standard cost of work spoiled.		
2. Spoiled Work Inventory	$xx	
Overhead Cost or Profit and Loss	xx	
Spoiled Work variance		$xx
To charge the salvage value of the spoiled work to inventory and the remainder as an overhead cost.		

Where the spoiled work is repaired, no special problems arise because the time tickets and excess material requisitions will show the repair costs so that they can be charged to variance accounts. When the **output method** is used, no special problems arise because the standard costs are computed on the basis of good units produced, and the cost of the spoiled units will automatically show up in the variance accounts. An inventory account will, of course, be charged for the market value of any scrap recovered.

DISPOSITION OF VARIANCES UNDER SINGLE PLAN. The methods for the disposition of variances from standard and the arguments for and against each method are the same as stated earlier in this section under Disposition of Variances Under Partial Plan. The entries made when the variances are to be closed to Profit and Loss and when they are to be distributed were previously shown as journal entries 9 and 10 in Journal Entries for Single Plan. The computations necessary when the variances are to be distributed are given here.

Because the materials price variance, under the single plan, must be distributed to the Raw Materials account as well as the In-Process, Finished Goods, and Cost of Sales accounts, it must be distributed first. The balance in this account is $600.00, but since the beginning inventory of Raw Materials is carried at standard cost in the illustration, there will be a beginning balance in the account (when the policy of distributing variances is followed) equal to the difference between the actual and standard cost of the beginning inventory, in this case $112.00. The total amount to be distributed is therefore $712.00. By using the ending balances from the illustration, the **materials price variance** can be distributed as follows:

	Ending Balance	Percent	Price Variance	Adjusted Balance
Raw Materials	$ 5,880.00	54.394	$387.28	$ 6,267.28
Materials in Process	1,050.00	9.713	69.16	1,119.16
Materials Usage Variance	10 00	.093	.66	10.66
Finished Goods	1,720.00	15.911	113.29	1,833.29
Cost of Sales	2,150.00	19 889	141.61	2,291.61
	$10,810.00	100 000	$712.00	$11,522.00

It will be noted that the actual cost of the Raw Materials inventory, as computed here, does not agree exactly with the cost as stated under the partial plan. This difference is caused by the fact that the price behavior of different materials varied considerably from the average. Additional accuracy could be obtained, if desired, by prorating the variances of the different materials individually or by groups with similar price behavior.

As stated before, many firms would stop with the proration of the materials price variance. If it is desired to prorate the remainder of the variances, the amounts and percentages of the various cost elements in the ending inventories and Cost of Sales accounts would be determined as follows:

	Materials		Labor		Overhead	
	Amount	Percent	Amount	Percent	Amount	Percent
In-Process	$1,119 16	21.342	$ 700.00	13 369	$ 520.00	10.358
Finished Goods.	1,833.29	34.959	2.016.00	38.503	2.000.00	39 841
Cost of Sales...	2,291 61	43.699	2,520 00	48.128	2,500.00	49.801
	$5,244.06	100.000	$5,236.00	100.000	$5,020.00	100.000

The above amounts are obtained by multiplying the number of units in each category by the standard material, labor, and overhead costs per unit. Where too many different kinds of products are manufactured to make this practical, the composition of the Finished Goods and Cost of Sales accounts may be estimated on the basis of the composition of the goods finished during the period.

The variances would then be allocated on the basis of the percentages computed in the preceding table as follows:

	In Process	Finished Goods	Total Inventories	Cost of Sales	Total
Materials usage	$ 2.27	$ 3.73	$ 6.00	$ 4.66	$ 10.66
Labor rate	$ 8.09	$ 23.29	$ 31.38	$ 29.12	$ 60.50
Labor usage	21.92	63.15	85.07	78.93	164.00
Total labor	$30.01	$ 86 44	$116.45	$108 05	$224.50
Overhead efficiency	$ 1.55	$ 5.98	$ 7.53	$ 7.47	$ 15.00
Overhead expense	6.81	26.20	33.01	32.74	65.75
Overhead utilization	40.68	156.47	197.15	195.60	392.75
Total overhead	$49.04	$188.65	$237.69	$235.81	$473.50
Total variances	$81.32	$278.82	$360.14	$348.52	$708.66

The closing entries, which would be made when the variations were allocated, were shown previously in journal entry 10 under Journal Entries for Single Plan. The financial statements should be the same as those in Fig. 8 but they would actually vary slightly because of the rounding of figures in averaging. The variances may also be distributed on a **first-in, first-out** or **last-in, first-out** basis.

JOURNAL ENTRIES FOR REVISION OF STANDARDS. The problem of recording revisions of standards is discussed under the heading Journal Entries for Revision of Standards under Accounting for Partial Plan; under the single plan there are no problems different from those under the partial plan.

Accounting for Dual Plan

Charging Work in Process at Actual and Standard Costs

CHARACTERISTICS OF THE DUAL PLAN. The distinctive features of the dual plan are:

1. Entries in inventory accounts are made at both actual and standard costs, and the two are carried in parallel columns in the ledger accounts. Only actual cost figures are carried into Cost of Sales and financial statements.
2. Variances are computed primarily in percentages rather than in absolute terms.
3. Both basic and current standards are used in some applications of this method, but in other applications only current standards are used.

ASSUMED FACTS FOR ILLUSTRATING DUAL PLAN. The use of the dual plan is illustrated first with the use of current standards only, and secondly with the use of both basic and current standards. The facts assumed for the partial and single plans are assumed again for the dual plan. These facts may be assembled by the output method (used with the partial plan in the previous illustrations) or by the input method (used with the single plan in the previous illustrations).

Journal Entries for Dual Plan:

	Actual Cost		Basic Standard Cost	
1. Entry for purchase of raw materials:				
Raw Materials	$ 9,100.00		$ 8,500.00	
Vouchers Payable, etc.		$ 9,100.00		
Standard Cost Clearing				$ 8,500.00
To record materials purchased at standard and actual cost. The Standard Cost Clearing account serves to maintain double entry balance for items entered at standard cost and ultimately serves to eliminate standard costs from the books without carrying them to Profit and Loss.				
2. Entries for direct material put into process:				
a. Charging actual cost column of Work in Process—				
Work in Process	$ 4,413.34			
Standard Cost Clearing			$ 4,120.00	
Raw Materials		$ 4,413.34		$ 4,120.00
To charge Work in Process with actual cost of materials used. This amount is computed by multiplying the standard cost of material used ($4,120.00) by 1.07120, the material price ratio, which is computed in the Raw Materials account (see Fig. 13).				
b. Charging standard cost column of Work in Process—				
Work in Process			$ 4,110.00	
Standard Cost Clearing				$ 4,110.00
To charge Work in Process with the standard cost of the standard quantity of material used.				
3. Entry for direct labor cost incurred:				
Work in Process	$ 4,806.50		$ 4,582.00	
Accrued Payroll		$ 4,806.50		
Standard Cost Clearing				$ 4,582.00
To charge Work in Process with actual and standard direct labor cost.				
4. Entry for actual overhead cost incurred:				
Overhead Cost	$ 4,893.50			
Vouchers Payable, etc.		$ 4,893.50		
To record the actual overhead cost for the period.				

	Actual Cost		Basic Standard Cost	
5. Entry for overhead costs applied:				
Work in Process	$ 4,435.00		$ 4,420.00	
Overhead Cost		$ 4,435.00		
Standard Cost Clearing				$ 4,420.00
To charge Work in Process with the actual and standard hours times the burden rate.				
6. Entry for work completed during month:				
Finished Goods	$11,941.89		$11,472.00	
Work in Process		$11,941.89		$11,472.00
To transfer units finished to Finished Goods at actual and standard cost. The actual amount is computed by multiplying the standard cost of goods finished by the Work in Process ratio which is computed in the Work in Process account (see Fig. 13).				
7. Entries for sales:				
a. Recording selling price—				
Accounts Receivable	$10,000.00			
Sales		$10,000.00		
To record sales for period				
b. Recording cost price—				
Cost of Sales	$ 7,456.58			
Standard Cost Clearing			$ 7,170.00	
Finished Goods		$ 7,456.58		$ 7,170.00
To transfer goods sold from Finished Goods account. The actual amount is computed by multiplying the standard cost of goods sold by the Finished Goods ratio which is computed in the Finished Goods account (see Fig. 13).				
8. Entries to close expense and revenue accounts:				
Sales	$10,000.00			
Cost of Sales		$ 7,456.58		
Overhead Cost		458.50		
Profit and Loss		2,084.92		
To close expense and revenue accounts.				

If it is assumed instead that both basic and current standards are to be used, the basic standards will be recorded in the accounts. **Ratios of current to basic standards** would have to be determined, however, so that the variances could be adjusted from ratios between basic standard costs and actual costs to ratios between current standard costs and actual costs. To illustrate this technique, it is assumed that the standard material cost figures used in the previous examples are basic standard costs and that the ratios between current and basic standard material costs are as follows:

$$\frac{\text{Basic material price standard}}{\text{Current material price standard}} = 95\%.$$

$$\frac{\text{Basic material usage standard}}{\text{Current material usage standard}} = 110\%.$$

JOURNAL ENTRIES FOR DUAL PLAN. The journal entries for the dual plan are shown above. The computation of the standard cost figures for these entries is the same as for the partial plan if the output method is to be used, or it is the same as for the single plan if the input method is to be used.

COMMON VARIATIONS UNDER DUAL PLAN. According to Neuner (Cost Accounting) there are three common variations in the way basic standard costs may be recorded under the dual plan, as follows:

1. Separate work-in-process accounts may be kept for each product or group of similar products.
2. Separate work-in-process accounts may be kept for each department or operation.
3. Separate work-in-process accounts may be kept for materials, labor, and overhead.

CALCULATION OF VARIANCES FROM STANDARD UNDER DUAL PLAN. Where the dual plan is used, two characteristics appear in connection with variances from standards:

1. The variances are not incorporated in the bookkeeping records but are derived statistically from information contained in the accounts.
2. The variances are expressed as ratios of actual to standard costs. If desired, these ratios can be translated into dollar amounts.

Direct Materials Cost Variances. The **materials price variance** ratio can be obtained directly from the Raw Materials account in the ledger (see Fig. 13). It is computed by dividing the actual cost of materials by the standard cost of the materials. Carrying out the calculation gives the following results:

Variance Ratio	Variance Amount
$\frac{\$9,100.00}{\$8,500.00} = 1.07059$	$\left.\begin{array}{r}\$9,100.00 - \$8,500.00 = \\ \text{or } \$8,500.00 \times .07059 = \end{array}\right\}$ \$600.00 loss

The **materials usage variance** ratio can be obtained by dividing the actual quantity of material used times the standard cost by the standard quantity of material used times standard cost. Carrying out the calculation gives the following results:

Variance Ratio	Variance Amount
$\frac{\$4,120.00}{\$4,110.00} = 1.00243$	$\left.\begin{array}{r}\$4,120.00 - \$4,110.00 = \\ \text{or } \$4,110.00 \times .00243 = \end{array}\right\}$ \$10.00 loss

Raw Materials

	Actual	A/S	Standard		Actual	A/S	Standard
Bal.	$ 1,612.00	1.07467	$ 1,500.00	(2a)	$ 4,413.34	1.07120	$ 4,120.00
(1)	9,100.00	1.07059	8,500.00	Bal.	6,298.66	1.07120	5,880.00
	$10,712.00	1.07120	$10,000.00		$10,712.00	1.07120	$10,000.00
Bal.	$ 6,298.66	1.07120	$ 5,880.00				

Work in Process

	Actual	A/S	Standard		Actual	A/S	Standard
Bal.	$ 650.00	1.03175	$ 630.00	(6)	$11,941.89	1.04096	$11,472.00
(2a,2b)	4,413.34	1.07381	4,110.00	Bal.	2,362.95	1.04096	2,270.00
(3)	4,806.50	1.04900	4,582.00				
(5)	4,435.00	1.00339	4,420.00				
	$14,304.84	1.04096	$13,742.00		$14,304.84	1.04096	$13,472.00
Bal.	$ 2,362.95	1.04096	$ 2,270.00				

Finished Goods

	Actual	A/S	Standard		Actual	A/S	Standard
Bal.	$ 1,480.00	1.03208	$ 1,434.00	(7b)	$ 7,456.58	1.03997	$ 7,170.00
(6)	11,941.89	1.04096	11,472.00	Bal.	5,965.31	1.03997	5,736.00
	$13,421.89	1.03997	$12,906.00		$13,421.89	1.03997	$12,906.00
Bal.	$ 5,965.31	1.03997	$ 5,736.00				

Standard Cost Clearing

(2a)	$ 4,120.00	Bal.	$ 3,564.00
(7b)	7,170.00	(1)	8,500.00
Bal.	13,886.00	(2b)	4,110.00
		(3)	4,582.00
		(5)	4,420.00
	$25,176.00		$25,176.00
		Bal.	$13,886.00

Overhead Cost

(4)	$ 4,893.50	(5)	$ 4,435.00
		(8)P&L	458.50
	$ 4,893.50		$ 4,893.50

Cost of Sales

(7b)	$ 7,456.58	(8)P&L	$ 7,456.58

Accounts Receivable

(7a)	$10,000.00		

Sales

(8)P&L	$10,000.00	(7a)	$10,000.00

Payroll

		(3)	$ 4,806.50

Vouchers Payable, etc.

Bal.	$13,993.50	(1)	$ 9,100.00
		(4)	4,893.50
	$13,993.50		$13,993.50
		Bal.	$13,993.50

Profit and Loss

		(8)	$ 2,084.92

Capital Stock

		Bal.	$ 3,472.00

Capital Stock in an amount equal to the beginning inventories was assumed so that the ledger would balance. Note that since the beginning inventories are all carried at actual cost, the amount required to balance is different from that required under the single and partial plans. The beginning balance in the Standard Cost Clearing account is equal in amount to the beginning inventories at standard cost.

Fig. 13. Ledger accounts for dual plan.

Direct Labor Cost Variances. The **labor rate variance** is obtained by dividing the actual hours worked times the actual rates by the actual hours worked times the standard rates. Carrying out the calculation gives the following results:

Variance Ratio	Variance Amount
$\frac{\$4{,}806.50}{\$4{,}746.00} = 1.01275$	$\left.\begin{array}{r}\$4{,}806.50 - \$4{,}746.00 = \\ \text{or } \$4{,}746.00 \times .01275 = \end{array}\right\}$ \$60.50 loss

The **labor usage variance** is obtained by dividing the actual hours worked times the standard rates by the standard hours worked by the standard rates. Carrying out the calculation gives the following results:

Variance Ratio	Variance Amount
$\frac{\$4{,}746.00}{\$4{,}582.00} = 1.03579$	$\left.\begin{array}{r}\$4{,}746.00 - \$4{,}582.00 = \\ \text{or } \$4{,}582.00 \times .03579 = \end{array}\right\}$ \$164.00 loss

The ratios computed here for direct materials and direct labor are actually **composite ratios,** since three kinds of material in one case and four kinds of labor in the other case have been added together to compute the ratio. Additional accuracy can be obtained by computing separate ratios for each material and each labor operation. These ratios would be as follows (the basic figures for these computations are given earlier in this section under Accounting for Partial Plan):

	Price Ratio	Usage Ratio
Material M–1	0.85000	1.15556
Material M–2	1.10000	1.11111
Material M–3	1.10000	0.91667
Operation 1	1.00000	1.31250
Operation 2	1.03125	1.02667
Operation 3	1.02857	0.82143
Operation 4	0.97436	1.00000

The extent to which materials and labor will be grouped for computing ratios will depend upon the detail desired. It is very common to go at least as far as grouping material into classes where many varieties of material are used.

Alternative Method for Computing Ratios. The same ratios may be computed differently:

1. Compute over-all ratio. This is found by dividing the actual quantities at actual cost by the standard quantities at standard cost.
2. Compute price ratio, if it is not already available. It is found by dividing the actual by the standard unit cost.
3. Compute usage ratio by dividing the over-all ratio by the price ratio. The over-all ratio may be expressed as a function of its component ratios:

$$\text{Price ratio} \times \text{usage ratio} = \text{over-all ratio.}$$

Hence, if any two ratios are known, the third may be found. Where the over-all and price ratios are known, the above equation is easily transformed to

$$\text{Usage ratio} = \frac{\text{over-all ratio}}{\text{price ratio}}$$

Overhead Cost Ratio. The overhead cost ratio is computed by dividing the actual overhead by the budgeted overhead cost at the actual activity level measured in labor hours. This ratio provides a comparison between actual spending and budgeted allowances, and for this reason is often referred to as the **spending rate** or **spending ratio.**

The actual overhead in column (1) is obtained from the debits in the departmental overhead accounts. (See journal entries 4b and 4c earlier in this section under Journal Entries for Partial Plan.) In addition to the two debits each to Departments A and B, there would be a proration of the $12.50 Power Cost Expense variance (journal entry 7) made on the basis of the actual consumption of the two departments (25,000 kw.h. for A and 65,000 for B.) Column (2) is the budgeted amount for the number of hours operated. It is found by interpolation in the flexible budget (Figs. 3 and 4).

Department	(1) Actual Overhead	(2) Budgeted Overhead (for hours worked)	(3) Expense Ratio (1) ÷ (2)	(4) Variance Rate (3) − 100%	(5) Expense Variance (2) − (1) or (2) × (4)
A	$2,014.47	$2,032.50	0.99113	0 00887	+$18.03
B	2,879.03	2,795.25	1.02997	0.02997	− 83.78

Overhead Efficiency Ratio. The overhead efficiency ratio is computed from the following formula:

$$\frac{\text{Allowed hours for actual production} \times \text{hourly rate}}{\text{Actual hours worked} \times \text{hourly rate}} = \frac{\text{allowed cost (for units produced)}}{\text{standard cost in product}}$$

Carrying out the calculations gives the following results:

Department	(1) Allowed Cost (for units produced)	(2) Standard Cost in Product	(3) Ratio (1) ÷ (2)	(4) Reciprocal of col. (3)	(5) Variance Rate (4) − 100%	(6) Dollar Variance (2) − (1) or (1) × (5)
A	$1,900.00	$2,065.00	0.92010	1 08684	0 08684	- $165 00
B	2,520.00	2,370 00	1 06329	0 94048	0.05952	+ 150.00

Overhead efficiency ratios provide a comparison between the standard direct labor hours and the direct labor hours actually used. The above ratios show that Department A has exceeded the basic standard hours by 8.68%, while Department B has used 5.95% less than the basic standard allowance.

Overhead Utilization Ratio. The overhead utilization ratio, also called the **capacity ratio** and **volume ratio,** is computed by the following formula:

$$\frac{\text{Standard cost in product}}{\text{Budgeted overhead cost}}$$

The tabulation below shows the method of computation and the variances:

Department	(1) Standard Cost in Product	(2) Budgeted Overhead (for hours worked)	(3) Ratio (1) ÷ (2)	(4) Variance Rate (3) − 100%	(5) Utilization Variance (1) − (2) or (2) × (4)
A	$2,065 00	$2,032.50	1.01599	0.01599	+$ 32.50
B	2,370.00	2,795 25	0.84787	0.15213	− 425 25

The above table indicates for Department A a small variance gain because, expressed in hours, it operated at slightly over normal capacity. Department B shows a substantial unfavorable variance because of operations below normal capacity. (For other methods of computing overhead variances, see section on Analysis and Control of Standard Cost Variances.)

ADJUSTING BASIC TO CURRENT STANDARD VARIANCES. When basic standards are used, the variance ratios show the percentage of deviation between actual costs and basic standard costs. By comparing these ratios over a period of time, the **trend of variations** may be observed. In effect these ratios are index numbers computed on a fixed base. This emphasis upon relative changes rather than absolute amounts of change is characteristic of the dual plan These ratios do not serve as measures of operating efficiency, however, for the basic standards may be considerably above or below the amounts which represent currently attainable good performances. For this reason the ratio between actual costs and current standard costs is usually determined under the dual plan

To determine this ratio, the ratio between current standards and basic standards must first be estimated. This ratio is then multiplied by the basic standard variance ratio to obtain a current standard variance ratio. Mathematically the formula is as follows:

$$\frac{\text{Actual cost}}{\text{Basic standard cost}} \times \frac{\text{basic standard cost}}{\text{current standard cost}} = \frac{\text{actual cost}}{\text{current standard cost}}$$

Using the assumed figures for materials, the calculation of the ratios would give the following:

Material price ratio:	1.07059 × .95 = 1 01706
Material usage ratio:	1.00243 × 1.10 = 1.10267

Comparison of Standard Cost-keeping Methods

GENERAL REQUIREMENTS FOR COST SYSTEM. Any cost accounting method must provide management with cost information needed to operate the business intelligently and efficiently. Closely linked with this first requirement is that of **economy in operation,** for costs should be not only obtainable but obtainable with a minimum expenditure of money and effort. Any practical system is necessarily a compromise between these two requirements because additions to the amount and accuracy of cost data to be provided entail more expense. The limit at which expansion should stop is the point where costs exceed the benefits returned for the expenditure. Consideration must also be

given to preferences and limitations of executives who are to use cost data; for the accountant's reports must be in a form which executives are able and willing to use in the management of the business.

Where optional methods are available for obtaining costs, the accountant must choose the one which gives the optimum balance between utility to management and cost of operation.

ADVANTAGES AND LIMITATIONS OF PARTIAL PLAN. Under this method Work in Process is charged at actual and credited at standard cost. Where the work to be costed comprises only a few simple operations, where clerical work must be kept at a minimum, and where frequent detailed analyses of variances from standard are not desired, the partial plan is serviceable. Nevertheless it has distinct shortcomings when the preceding conditions do not obtain. These are:

1. Variances are not revealed until the end of the accounting period and after an inventory of work in process has been taken. It is then too late to avoid losses that have occurred by reason of waste or inefficiency in the factory. Strong and positive control of operations to ensure that standards are met requires immediate rather than delayed reports on variances.
2. Separation of total cost variance into its elements requires the collection of additional statistics not available from the accounting records. These may not be readily available, and cost must be incurred to keep and summarize them. Hence variances are not developed automatically as part of the bookkeeping routine, nor does the method always provide material from which to compute them.

These limitations are doubtless responsible for the infrequent application of this method.

ADVANTAGES AND LIMITATIONS OF SINGLE PLAN. Because Work in Process is charged and credited at standard, this method has, as its principal advantages, promptness with which variances from standard costs are disclosed, simplicity and economy with which accounts are operated, and the ability to provide analysis of variances in as much detail as the management may desire. It is based primarily upon the theory that standard costs are real costs suitable for inclusion in the financial statements. It is, however, possible to close the variance accounts into Cost of Sales and inventories for the purpose of stating these items at actual cost, although distribution of variance balances is apt to be a rather rough estimate. There is, however, no serious objection because of the fact that variances are not attached to particular units of goods whose manufacture has caused them to arise. The method of variance disposal does not, of course, affect the detailed assignment of responsibility for variances before the goods reach the finished stage. It is for the above reasons that this plan, with modifications to meet individual plant requirements, is probably the most common.

A more serious criticism of this method comes from a steel manufacturer using the dual plan. According to this source it is practically impossible to allocate variances to product classes under the single plan with any accuracy. Furthermore, unless the standards are extremely accurate and are continuously revised, the cost of the product is meaningless if there are many or substantial changes in prices, labor rates, methods of manufacture, etc. The single plan gives control information, but the cost information is not particularly useful. This limitation is an especially serious one for companies with cost-plus contracts with the government or others.

ADVANTAGES AND LIMITATIONS OF DUAL PLAN. The dual *plan provides essentially the same information as the single plan but has as its* principal feature the use of **percentages rather than amounts.** Thus it relies upon arithmetical processes of division and multiplication rather than upon addition and subtraction, as do the other methods. In comparison with the single plan, it is not so effective in providing variance data with **promptness** because it is necessary to have entries made in the accounts and the ratios computed before actual performance can be compared with standards. In contrast with the single plan, the dual plan is based upon the theory that only actual costs should be carried into the financial statements, and standard costs are accordingly cleared from the books as soon as they have served their purpose as aids to control of manufacturing operations.

The main **advantages** obtainable with the dual plan are:

1. Through use of basic standards which remain unchanged it is possible to **measure trends** in performance over a considerable period. This enables management to observe tendencies in the price of materials and labor, to determine what progress is being made in reducing the physical usage of cost elements by eliminating waste and improving performance, and to compare such trends in cost with trends in market price of the company's products in order to see whether the spread (or gross profit) is increasing, decreasing, or remaining constant. Maintenance of a proper balance between rates of change in these variables is often more important to management than amounts spent and taken in. Hence, to management, a technique which expresses these data as relatives to a fixed base may have distinct value. In addition management is provided with a long range historical picture of operations which helps explain why profits or losses have been sustained. When the direction and **rates of change** in such variables are known, it is possible to project them into the future to aid the planning of future operations. Information of this type is not so readily obtained from accounting methods which use current rather than basic standards.
2. This method emphasizes the advantages which relative figures have over absolute figures, since it computes variances in percentage form. Management is thus enabled to judge the **degree of variation** from a fixed standard.
3. The dual plan reveals actual and standard costs by product lines in as much detail as does the single plan if not more.

The dual plan also has certain **disadvantages** which, under some conditions, are serious enough to make it undesirable. These are:

1. It is more **complex** and thus more difficult to understand than the other two methods. Even though the accountant may be thoroughly familiar with the method, he may find it a hard task to explain to an executive how his cost figures were derived. To a lesser extent this is true of all standard cost plans.
2. While much labor can be saved by grouping items and computing such individual costs as may be desired by applying ratios to basic standards, the real details are sacrificed in the process of averaging, which produces the ratios. Much care must be used in designing the system, to avoid obscuring important differences in cost and emphasizing others of small consequence. In order to preserve these details, a sufficiently large number of accounts must be carried in the factory ledger. Here again it is a question of the amount of detail desired. Every detail is available for control if desired, but some grouping must be done under any plan to condense the voluminous data into some intelligible form. Thus one manufacturer under the dual plan accumulates departmental data by product

classes for each payroll period. It is then summarized by classes for the month. Only one set of entries is then made. Cost of Sales for the month, previously priced at standard, is adjusted in the monthly summary. This plan has proved a real work saver.

3. The dual plan may involve more clerical work than the single plan because **parallel entries** at both standard and actual cost must be made. The work added by this latter feature may, under favorable conditions, be offset by grouping items into a few accounts and computing actual costs with the aid of ratios developed in these accounts.

4. Since comparisons with basic standards do not provide good measures of **efficiency,** it is necessary to use a second set of standards representing current performance. This double set of standards, each of which has a different meaning, may be confusing to those who use the figures; it also involves a certain amount of additional work in setting the standards. Furthermore, it is possible that current standards may be unscientific estimates if the company feels that the problem of setting standards has been solved when basic standards are set. Basic standards are merely convenient reference points from which to measure subsequent changes, and current standards are really the ones used to maintain **control of costs.** For this reason it is much more important to have **current standards** scientifically set than it is to have basic standards precisely set.

At times this may be an unfair criticism of the dual plan. Basic standards are changed from time to time when necessary. They do not, however, require frequent changing. The latter is the occasion for considerable work under other plans. Hence, because of the relative infrequency of revisions of standards under the dual plan, the work is more likely to be done carefully. Finally, although reliable figures are not available, it appears that very few companies use basic standard costs.

In discussing the various ways in which standard costs are entered on the books, it seems well to conclude with the observation made by a team of European experts (Organization for European Economic Co-operation) at the end of their chapter on standard costs in their report on how American companies used accounting (Cost Accounting and Productivity, The Use and Practice of Cost Accounting in the U.S.A.):

> But there was no uniform way in which American companies solved their problem of accounting for standard costs. Each firm tried to adapt its system to its special conditions, circumstances, and needs, and all work and every feature of the accounting system had to justify itself. Everything had to have a real purpose and pay its own way.

SECTION 17

ANALYSIS AND CONTROL OF STANDARD COST VARIANCES

CONTENTS

CONTENTS (*Continued*)

SECTION 17

ANALYSIS AND CONTROL OF STANDARD COST VARIANCES

Variance of Actual Costs from Standards

"VARIANCE" AND "VARIATION." The difference between the costs actually incurred and the standard or estimated costs is known as cost variance or cost variation. Schlatter and Schlatter (Cost Accounting) discuss the two terms and conclude that, "Variation is the better word for our purpose unless variance can be said to be the correct word because of the sanction of special usage by cost accountants." Both terms are used frequently in cost accounting literature, but since "variance" appears to be the more widely adopted of the two, it is used in the main in this Handbook.

SIGNIFICANCE OF COST VARIANCES. The meanings of such variances are dependent upon the kind of costs with which actual costs are compared. Cost variances resulting from careless estimates do not have the same significance as cost variations caused by rigorous or "tight" standards. Variances should be interpreted with consideration of the care with which estimates or standards have been set and of the tightness of the standards.

Because **estimated costs** may represent guesses more or less carefully made, variances from these estimates reveal the accuracy of the guesses; the amount of the variances show only how good the guesses were. On the other hand variances from **carefully established standards** indicate how closely actual costs correspond to what they should have been. Between careless estimates and carefully set standards are many degrees of more carefully made estimates and less carefully set standards, and to understand clearly the particular variances, it is necessary to know from what they vary. In NAA Research Series No. 22 (NAA Bulletin, vol. 33) the position is taken that, "Since variances are measures of performance under standards, the standards must first be good in order to yield reliable measures of performance."

Failure to recognize the importance of understanding the bases from which variances are computed sometimes has been the cause of disputes concerning the proper treatment in the **financial statements** of cost variances. It would be reasonable (at least in theory) to argue that variances from estimated costs should be eliminated by adjusting inventories and costs of sales to actual costs. On the other hand, it would also be reasonable to argue that debit variances from good standards represent losses because they are costs incurred in excess of those necessary to produce the product.

In practice, it is often difficult to determine what kinds of standards are used, and therefore it becomes difficult to interpret variances. The problem is often complicated by the fact that standards for some cost elements may be very carefully set, and standards for other elements may be no better than poor guesses.

Quantity standards typically can be more carefully established than can **price standards.**

As many cost variances exist as there are elements of cost, and they may be analyzed in a great variety of ways in order to determine causes. Here an attempt it made to indicate some of the principal types of **variance analyses,** but many more than can be presented here are possible.

PURPOSES OF VARIANCE ANALYSIS. Assuming the existence of proper standard costs for the product of an operation, function, or department, the executive in his concern for cost control may concentrate his attention on discrepancies between actual and standard costs. The usefulness of comparisons between actual and standard costs is based on the **principle of exceptions,** which makes it possible for the cost accountant to sift from the great mass of his cost data the essential facts needed by management. Cost variances from standards represent deviations from what costs ought to be.

Bennett (Standard Costs: How They Serve Modern Management) explains the **significance of variances** as follows:

> It is probably a fair and accurate statement to say that the analysis of cost variances is usually the most important job to be done in operating a standard cost system. Without proper analysis and intelligent, factual interpretation, the cost variances are just so many figures. Only through the medium of this analytical device can the figures tell the story of what is happening and point the way to improvement procedures. Here is where the standard cost system leaves the realm of technical accounting and dull debits and credits and enters the rarefied atmosphere of interpretive and creative analysis for management guidance. At this point, also, the accountant who is blessed with the gift of vision and imagination steps out from the maze of debits and credits and becomes the valued interpreter of the business facts of life.

Bennett points out the need to be alert to the possibility that there may be substantial losses which largely offset each other, such as a rapidly expanding volume covering up inefficiencies that need correction. He states that, "The object of variance analysis is to reveal the difficulties quickly and before they become ingrained—not after they have continued so long that they can be discovered by inspection."

In explaining the role of variance analysis in **cost control,** in NAA Research Series No. 22 (NAA Bulletin, vol. 33) the NAA Research Committee states: "Past losses from failure to meet standards cannot be retrieved, but the study of variances is an important step toward improving performance in the future."

An important function of the cost accountant is to draw the attention of operating executives promptly to the existence of variances from standards. When a significantly large cost variance appears, the cost accountant should be able to present an analysis to management, making it possible to determine: (1) where the variation occurred, (2) who was responsible, and (3) why it happened. Such an analysis requires that cost records show in what department the variance occurred; then, from a knowledge of the organization, the person responsible is determined, and further investigation should disclose the cause of the variance.

The process of currently **checking actual performance against standards** is the function of two departments:

1. The **inspection department,** which carries out comparisons with physical standards.
2. The **cost accounting department,** which collects and classifies the data for comparison of actual with standard costs.

From these two comparisons, but chiefly from the latter, come reports summarizing the results of performance as measured against standards in order that executives may be currently informed concerning the work over which they have authority and for which they are responsible. Both these activities should be accurately done and adequately recorded.

MATERIALS COST VARIANCE COMPUTATIONS AND CAUSES.

The cost variance for any material is the difference between the actual cost of that material and its standard cost. Ordinarily this variance may be made up of a **materials price variance** and a **materials usage variance,** although, when an aggregate materials cost variance is computed for several materials considered together, **yield** and **mix variances** may also be included.

Causes of Materials Price Variances. A materials price variance is the result of a difference between the actual price and the standard price of a unit of material. There may be as many price variances as there are kinds of materials. If the standard price of a unit of Material M–2 is $7.00, and the actual price paid is $7.70, the unfavorable price variance (loss) per unit is $0.70, or 10 percent of the standard price. The significance of this **unit price variance** is dependent on several factors:

1. The possibility of determining a real standard unit material cost (price), i.e., the unit cost that should be incurred.
2. The costs included in the standard "price."
3. The ratio between the variance and the standard price.
4. The number of units to which the unit variance is applicable.

For some kinds of materials that have frequently **fluctuating market prices** which cannot be forecasted reliably and which cannot practicably be purchased under long-term contractual arrangements, variances from standard may have little significance. Under these circumstances variances may be principally the result of uncontrollable market price fluctuations. Other causes of price variances may be at least partly controllable. Lang–McFarland–Schiff (Cost Accounting) state:

> Material price variances may be caused by (1) fluctuations in market prices of materials; (2) purchasing in nonstandard lots; (3) purchasing from unfavorably located suppliers, thereby incurring additional transportation costs; (4) excessive shrinkage or losses in transit; (5) payment of additional charges for special handling or faster transportation; (6) purchasing from suppliers other than those offering most favorable terms; or (7) failure to take cash discounts available.

When a price variance is large, further analysis by causes may be useful for cost control purposes.

Constituent Parts of Materials Price Variances. "Price" may include only the invoice cost of the material, but it may also include **transportation and handling costs.** Excessive costs of transportation and handling may cause a part of the price variance, and this portion of the variance may be controllable and therefore significant. If possible the controllable portion of a price variance should be segregated from the uncontrollable in reports to management.

The amount of the **percentage variance** (in the illustration given. 10 percent) is important; standards themselves can be accurately set only within certain limits, and these limits must be recognized in order to decide whether any given percentage variance is significant.

The number of units of the material to which the unit price variance is applicable is important. Materials price variances are computed either on materials

purchased or on materials used. If the standard prices are valid standards based on long-term purchase commitments or on good price forecasting, it is preferable to compute and record materials price variances at the time of purchase. NAA Research Series No. 12 (NAA Bulletin, vol. 29) reports that in a NAA field study of 72 companies using standard costs, ". . . it was found that three-fourths of the companies price materials at standard when the materials are received." This method has two advantages:

1. From the cost control point of view, price variances (from valid standards) are a function of purchases rather than of use.
2. Recording standard prices in the stores ledger requires less clerical effort and expense.

Under this method, however, if "standard" prices are only estimates of actual prices, it is probably necessary to adjust the material inventory figures from these estimates to actual prices for financial statement purposes.

To illustrate the computation of materials price variance, assume that for material M–2, the standard price is \$7.00 and the actual price is \$7.70, and that 300 units were purchased during the month and 205 units were used in production. The \$0.70 price variance per unit is multiplied by the appropriate number of units, which may be, preferably, the units purchased (300), or the units used (205). Material M–2 price variance is then:

$$(\$7.00 - \$7.70) \times 300 = -\$210$$

or

$$(\$7.00 - \$7.70) \times 205 = -\$143.50$$

(Favorable variances are indicated by plus signs; unfavorable, by minus signs.)

Deferred Materials Price Variances. This materials price variance may be expressed as a simple formula:

$$(\text{Standard price} - \text{actual price}) \times \text{actual quantity} = \text{price variance}$$

or

$$(\text{SP} - \text{AP}) \times \text{AQ} = \text{PV}$$

This formula is the way in which the variance is sometimes computed in cost accounting literature. A mathematician would be more likely to use symbols like the following:

V_p = materials price variance.
V_u = materials usage variance.
p_s = standard price of material.
p_a = actual price of material.
q_p = quantity of materials purchased.
q_a = actual quantity of materials used.
q_s = standard quantity of materials used.

Then

$$V_p = (p_s - p_a)\, q_p$$

or

$$V_p = p_s q_p - p_a q_p$$

Lang–McFarland–Schiff (Cost Accounting) suggest a possible objection to the use of a price variance computed for materials purchased and also offer a solution to the objection:

If the plant follows the practice of charging variances to Profit and Loss at the time when purchases are made, there may be marked fluctuations in net profit that

have no connection with production and sales. This effect upon the profit and loss statement can, however, be avoided by setting up price variances as deferred items to be written off as materials are put into process or as goods are sold.

Under this procedure, the entries called for in the illustration are as follows:

–1–

Material M–2	$2,100.00	
Materials Price Suspense	210.00	
Accounts Payable		$2,310.00

(To record purchase of 300 units of material M–2 at standard cost, charging price variance to a suspense account.)

–2–

Work in Process	$1,435.00	
Material M–2		$1,435.00

(To record issuance of 205 units of material M–2 at $7.00 standard cost.)

–3–

Materials Price Variance	$ 143.50	
Materials Price Suspense		$ 143.50

(To relieve suspense account of the price variance at $0.70 each on 205 units issued.)

On the balance sheet, the inventory will include amounts for material M–2 as follows:

Materials	$665.00	
Materials Price Suspense	66.50	$731.50

Those who believe that price variance losses are a function of purchasing would object to deferring such losses to future periods under circumstances in which the standard prices can be accurately predetermined. They would argue that the loss should be charged to the period in which it is incurred and that it has nothing to do with production or sales.

When there is a **price variance gain**, some accountants feel that there will be an anticipation of profits and an overstatement of inventories to the extent that price variance on materials not put into production is closed to Profit and Loss for the period. The operation of the Materials Price Suspense account described before prevents this. The price variance gain on materials not used will be in the suspense account at the end of the period and will be shown on the balance sheet as a reduction of the inventory, thus bringing it down to "actual" cost.

Materials Usage Variances. A materials usage variance is the result of using more or less than a standard number of units of a material in production. The cause may lie in the material itself or in the men or machines fabricating the product. Materials usage variances are usually caused by one or more of the following:

1. Changes in design of product, machinery, tools, or method of processing not yet recognized in standards.
2. Substitution of nonstandard materials.
3. Variations in yield from materials.
4. Carelessness in not returning excess materials to stockroom.
5. Loss or destruction of materials by inadequately trained, poorly supervised, careless, or dissatisfied workmen.
6. Too rigid inspection.
7. Lack of proper tools or machines.
8. Failure to keep machines and tools in good working condition.

The cost analyst must not assume that a favorable usage variance for a particular material necessarily reflects greater efficiency or better control. He must make certain by analysis that this favorable variance is not offset by an unfavorable variance in some other cost. For example, the reduction of **materials spoilage** may be more than offset by an unfavorable labor efficiency variance resulting from excessive (uneconomical) care in handling the materials in the manufacturing process.

A materials usage variance may be expressed in terms of units, in terms of percentage variance from standard, or in terms of the standard cost of the number of units of variance. The **percentage variance** may give some indication of the **degree of variance controllability.** For example, in setting standards for the usage of a particular material, accuracy closer than 2 percent may be impossible or impracticable to attain. If so, a materials usage variance of only 1 percent would not be significant, while a variance of 5 percent would be significant for control purposes.

Ordinarily the task of determining usage standards falls to the engineers, and they are therefore best able to judge the degree of reliability of the standards and the amount that the percentage variance must be before becoming significant

Patrick (Accounting Review, vol. 32) suggests testing the significance of materials usage variances through the use of statistical methods based on historical data. The historical data may be used to establish a relation between usage variance and consumption of materials. From this data a **regression line** and a **standard error of estimate** may be determined, and from these, **control limits** about the regression line may be determined. If three times the standard error of estimate is selected for the control limits (according to Patrick), variances outside these limits should be investigated because there is very little probability that they are the result of chance.

Materials Usage Variance Computation. Measuring usage variances in terms of number of units has some importance for control purposes, but it is probably less important than when measured in terms of the standard cost of the variance in number of units. For example, information that 100 extra units were used is insufficient until those units are valued in terms of dollars. The use of 100 extra units with a standard price of \$0.01 is far less important than the usage of 100 extra units with a standard price of \$10. Usage variations are ordinarily expressed in terms of dollars and are computed by multiplying the number of units in the variance from standard by the standard price.

For example, assume that the standard price of material M–2 is \$7.00, that the standard quantity in the product of the month is 200 units, and that the actual quantity used is 205 units. The five extra units are 2½ percent of the standard quantity (200). The materials usage variance loss would be computed as follows:

$$(200 - 205) \times \$7 = -\$35$$

The **materials usage variance** may be expressed as a formula:

(Standard quantity − actual quantity) × standard price
= materials usage (or quantity) variance

or

$$(SQ - AQ) \times SP = QV$$

or using the mathematical terms listed under the materials price variance formula:

$$V_u = (q_s - q_a)\, p_s$$

or

$$V_u = p_s q_s - p_s q_a$$

(1) Type of Material	(2) Standard Unit Cost	(3) Actual Unit Cost	(4) Standard Quantity (in product)	(5) Actual Quantity	(6) Standard Quantity at Standard Rate	(7) Actual Quantity at Standard Rate	(8) Actual Quantity at Actual Rate	(9) Variances* Over-all (6) − (8)	(10) Variances* Usage (6) − (7)	(11) Variances* Price (7) − (8)
M-1	$1.00	$ .85	500	520	$ 500.00	$ 520 00	$ 442.00	+$ 58 00	−$20.00	+$ 78.00
M-2	7.00	7.70	200	205	1,400 00	1,435 00	1,578.50	− 178 50	− 35.00	− 143.50
M-3	2.00	2.20	1,080	1,080	2,160.00	2,160.00	2,376.00	− 216.00	0	− 216.00
Totals					$4,060.00	$4,115.00	$4,396.50	−$336.50	−$55.00	−$281.50

* **Minus** = unfavorable variances. Plus = favorable variances.

Fig. 1. Materials cost variances.

On the assumption that price variances are computed on materials used, another method represents a mechanical arrangement of the data (Fig. 1) which makes possible the automatic computation of materials variances by totals and in detail. Under this method an over-all variance is first obtained; this is then broken down into usage and price variances. The advantage results from the fact that unskilled clerical labor may be used to make the necessary computations.

The basic assumed facts in Fig. 1 appear in columns 1 to 5, inclusive. Information in columns 1 and 2 is taken from the **standard cost card.** Column 3 is based on **stock ledger cards** or other records. Column 4, the standard quantity in the product, is based on **production records** combined with standard and physical requirements as shown by the standard cost card. Column 5, of course, represents actual production figures, taken from the daily or summary **production reports.** The remaining columns are merely different combinations of the information in the first four. Thus, the **over-all variance** is obtained by comparing the standard quantity at standard rates with the actual quantity at actual rates (col. 6 minus col. 8). The resulting figure is used as a check figure against price and usage variances.

The difference between columns 6 and 7 in Fig. 1 shows **usage** or **quantity variance.** This is because both columns use standard rates, thus holding that factor constant; any difference is therefore due to a materials usage, greater or smaller than the allowed standard.

The difference between columns 7 and 8 is the **price variance.** Here the quantity is held constant; hence the difference is due to a price departure from standard. Cross-footing columns 10 and 11 should give the totals in column 9.

(1) Type of Material	(2) Standard Unit Cost	(3) Actual Unit Cost	(4) Quantity Purchased	(5) Quantity Purchased at Standard Rate	(6) Quantity Purchased at Actual Rate	(7) Materials Price Variance (5) − (6)
M-1	$1 00	$ .85	450	$ 450 00	$ 382 50	+$ 67 50
M-2	7.00	7.70	300	2,100.00	2,310.00	− 210 00
M-3	2.00	2.20	1,100	2,200 00	2,420 00	− 220 00
Totals				$4,750 00	$5,112 50	−$362.50

Fig. 2. Materials price variances.

(1) Type of Material	(2) Standard Unit Cost	(3) Standard Quantity (in product)	(4) Actual Quantity	(5) Standard Quantity at Standard Rate	(6) Actual Quantity at Standard Rate	(7) Materials Usage Variance (5) − (6)
M-1	$1.00	500	520	$ 500.00	$ 520.00	−$ 20 00
M-2	7.00	200	205	1,400 00	1,435 00	− 35 00
M-3	2.00	1,080	1,080	2,160.00	2,160 00	0
Totals				$4,060.00	$4,115.00	−$ 55.00

Fig. 3. Materials usage variances.

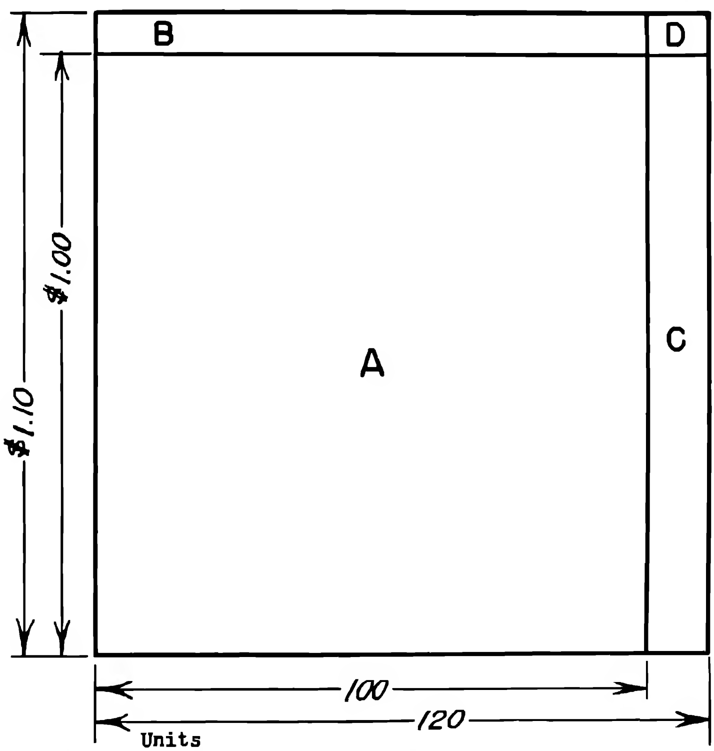
To get the combined variances on all materials, total all columns from 6 to 11, inclusive, and cross-check them.

A similar method requiring two schedules is possible when price variances are computed at the time materials are purchased, as shown in Figs. 2 and 3.

Overlapping of Price and Usage Variances. The NAA Research Staff discusses the logical and mathematical foundation which underlies the techniques of variance calculation (NAA Bulletin, vol. 34) and illustrates the "area" relationship of price and quantity variance as shown in adapted Fig. 4. Area *D* ($2.00) in Fig. 4 is the joint result of **price and quantity variances.** The usual

RELATIONSHIP OF PRICE AND QUANTITY VARIANCE "AREAS"

Standard price per unit	$1.00
Actual price per unit	1.10
Standard quantity	100 units
Actual quantity	120 units



The area designated as "A" represents the standard cost (100 units @ $1); area "B" is the variance ascribable solely to the price variance of $0.10 per unit (100 units @ $0.10); area "C" is the variance ascribable solely to the excess quantity (20 units @ $1); area "D" is the remaining portion of total variance due to excess price times excess quantity. (20 units @ $0.10).

Fig. 4. Area relationship of price and quantity variance.

method of variance computation, as shown in this section, includes area *D* with area *B* to make up the price variance:

Price variance ($1.00 − $1.10 = $.10 × 120 units)	= $12.00
Quantity variance (100 units − 120 units = 20 × $1.00)	= 20.00
Total materials variance loss	= $32.00

The alternative method would be:

Price variance ($1.00 − $1.10 = $.10 × 100 units)	= $10.00
Quantity variance (100 units − 120 = 20 × $1.10)	= 22.00
Total materials variance loss	= $32.00

The NAA Research Staff (NAA Bulletin, vol. 34) points out that:

> The mathematical logic underlying variance computations offers no guidance in choosing from the possible alternatives in disposition of the joint product of the two variances, i.e., area *D*. Instead, the answer must be sought by asking what method yields information most useful to management.

The cost accountant's primary interest is in **cost control**, which is best served by measuring variances in terms of responsibilities. Since the persons responsible for the quantity of materials used are not usually responsible for the unit price paid, the dollar amount of the quantity variance should be in direct proportion to the physical units in the quantity variance. This is the basis of the first method used here, in which the difference between the physical quantities is multiplied by the standard unit price. In similar fashion it is reasoned that the purchasing agent does not control the quantity of materials used, and therefore the most useful price variance is the difference between standard and actual unit prices multiplied by the number of units purchased.

Mix and Yield Variances. Nickerson (Cost Accounting) points out that variances in the **proportions of materials used** in producing some products are possible and that a type of analysis other than the usage variance analysis already described may be useful for management:

> A mix variance is often found in situations where a given mix or batch of materials is supposed to meet certain chemical or physical specifications or characteristics but where factors such as temperature, humidity, and minor variations in the materials used either require or allow a somewhat different combination of materials than called for under the assumed normal specifications. . . . There are, however, many situations in which a change in the mix of raw materials may affect the yield of finished product, and where this is the case, care must be taken that efforts aimed at achieving favorable mix variances are not more than offset by unfavorable yield variances.

To illustrate, assume that the standard specifications per 10 pounds of product R are as follows for materials:

Material A: 8 lb. at $1 per lb.	$ 8 00
Material X: 4½ lb. at $2 per lb.	9.00
Mixed materials A and X: 12½ lb.	$17.00

Product R produced during the month amounted to 6,600 lb.

Material A used: 4,700 lb.
Material X used: 3,300 lb.

The **material-mix variance** may be computed as shown in the accompanying table:

Type of Material	Actual Quantities Used (lb.)	Standard Proportions of Input* (lb.)	Difference (lb.)	Standard Prices	Material-Mix Variances
A	4,700	5,120	+420	$1	+$420
X	3,300	2,880	−420	$2	− 840
Totals	8,000	8,000	0		−$420

* Standard proportions for A and X are 8 to 4½.

The **material-yield variance** may be computed as follows:

Actual yield of product R	6,600 lb.
Standard yield of product R:	
8,000 × 10/12.5	6,400
Yield gain in product	200 lb.
Yield gain in dollars: 200 × $17/10	$340

The **mix-variance loss** of $420 is partly offset by the **favorable yield variance** of $340, giving a net materials usage variance loss of $80. An analysis of usage variance for the same data by types of materials would have yielded the following results:

Material A:	
Standard usage: 8/10 × 6,600 lb.	5,280 lb.
Actual usage	4,700
Usage variance	+580 lb.
Usage variance in dollars: 580 × $1	+$580
Material X:	
Standard usage: 4.5/10 × 6,600 lb.	2,970 lb.
Actual usage	3,300
Usage variance	−330 lb.
Usage variance in dollars: −330 × $2	−$660
Net materials usage variance: +$580 − $660	−$ 80

In the circumstances assumed in this illustration, i.e., that different mixes of materials and resulting differences in yields of product from the materials are possible, the analysis of the total usage variance loss into mix and yield variance provides more useful information to management than does the analysis into usage variance for each kind of material.

DIRECT LABOR COST VARIANCE COMPUTATIONS AND CAUSES. The direct labor cost of a product is a function of wage rates and of time worked; consequently total labor cost variances are caused by two factors, variances of wage rates from standard, and variances of hours from standard.

Wage Rate Variances. A wage rate variance is the difference between an actual and a standard wage rate. The significance of such a variance is a function

of the number of hours for which wages were paid and of the percentage of the variance to the standard. It is dependent, as is true for all variances, on the possibility of determining a real standard.

According to Blocker and Weltmer (Cost Accounting), **variances from standard wage rates** may be caused by:

1. Using employees with the wrong classification and wage rate for jobs.
2. Paying above or below standard rates during seasonal or emergency operations.
3. Paying guaranteed day rates to workers who are not able to earn established piece rates.
4. New workmen not paid established standard rates.
5. Personal favoritism of supervisors in promoting employees to higher job classifications and rates without proper authorizations.

To illustrate the computation of a wage rate variance, assume that in operation 3 (see Fig. 5) the standard hourly rate is \$3.00, the actual hourly rate is \$3.20, and the actual hours are 230. The unfavorable wage rate variance per hour is then \$0.20, which is 6⅔ percent of the standard rate. The unfavorable wage rate variance is computed as follows: (\$3.00 − \$3.20) × 230 = −\$46. The same formula used in the **material price variance computation** may be used here, i.e.:

$$(SP - AP) \times AQ = \text{wage rate variance}$$

Labor Efficiency Variances. A labor efficiency (or time) variance is the result of using more or less time than standard in an operation or process. There are a very large number of possible reasons for such variances. Fig. 6 gives a form from NAA Research Series No. 22 (NAA Bulletin, vol. 33) for the **analysis of manufacturing efficiency** that indicates various possible reasons for efficiency variances. Such efficiency variances have an effect on overhead costs as well as on labor costs. Analysis of the causes of total labor and overhead efficiency variance for an operation will often be of value in cost control.

The amount of a labor efficiency variance may be related to the amounts of other variances, and therefore by itself alone cannot be understood completely. For example, a favorable labor efficiency variance may be the result of using higher than standard-grade labor for the operation and may be counterbalanced by a wage rate variance loss caused by the higher wage rates paid to the more highly skilled laborers.

Labor Efficiency Analysis. To illustrate the computation of a labor efficiency variance, assume that in operation 3 (see Fig. 5) the standard hours for the production of the period are 240, the actual hours are 230, and the standard wage rate is \$3 per hour. The labor efficiency variance gain in hours is 10, which is a little more than 4 percent of the standard. This labor efficiency variance gain amounts to \$30, which is computed as follows: (240 − 230) × \$3 = \$30. The same formula in the **materials quantity (or usage) variance computation** may be here used, i.e.:

$$(SQ - AQ) \times SP = \text{labor efficiency variance}$$

In this case the actual hourly rate was \$3.20, and it is possible that the favorable efficiency variance was caused by the same factor that caused the wage rate variance loss of \$46 computed in Fig. 5. If so the net result of using higher-grade labor was a net labor variance loss of \$16. A mechanical arrangement of the labor cost data similar to that illustrated in Fig. 1 for materials cost data is possible for the automatic computation of labor variances. This arrangement is given in Fig. 5.

(1) Operation	(2) Standard Hourly Rate	(3) Actual Hourly Rate	(4) Standard Hours (in product)	(5) Actual Hours	(6) Standard Hours at Standard Rate	(7) Actual Hours at Standard Rate	(8) Actual Hours at Actual Rate	(9) Variances: Over-all (6) − (8)	(10) Variances: Efficiency (6) − (7)	(11) Variances: Rate (7) − (8)
1	$2.00	$2.00	500	525	$1,000	$1,050	$1,050	−$ 50	−$ 50	$ 0
2	2.40	2.60	1,500	1,540	3,600	3,696	4,004	− 404	− 96	− 308
3	3.00	3.20	240	230	720	690	736	− 16	+ 30	− 46
4	3.80	3.60	560	560	2,128	2,128	2,016	+ 112	0	+ 112
Totals					$7,448	$7,564	$7,806	−$358	−$116	−$242

Fig. 5. Direct labor cost variances.

Departmental Manufacturing Efficiency on Completed Operations

——— Plant

Dept. No...........

Code	Reason for Variance		Month of Actual Hours	Month of Variance Hours	Month of Cost	Year to Date Actual Hours	Year to Date Variance Hours	Year to Date Cost
0	No reason variances less than 10 per cent.	C						
1	Estimated running time too high. Reported to Stds. Dep't.	N						
2	Estimated set-up time too high. Reported to Stds. Dep't.	N						
3	Men's effort and/or ability above average.	C						
5	New machine, standard has not been changed.	N						
6	Change in methods, standard has not been changed.	N						
7	New or improved tools, standard has not been changed.	N						
8	Used set-up from previous job.	C						
9	Time set for man operating one machine. Ran two.	C						
10	Time clock registers to 0.1 hour only.	N						
11	Work done under special supervision.	C						
	Total Gains							
0	No reason variances less than 10 per cent.	C						
51	Standard too low. Reported to Standards Department.	N						
52	First time job was made.	C						
53	Slow or obsolete machine used.	N						
54	Planning not correct. Was changed. Stds. Dep't. notified.	N						
55	Could not follow oper. as planned, delivery requirements.	N						
56	Operations in previous departments not performed as planned.	C						
57	Time set for man operating two machines. One available.	N						
58	Quantity too small.	N						

Fig. 6. Analysis of direct labor variances.

Code	Reason for Variance		Month of Actual Hours	Month of Variance Hours	Month of Cost	Year to Date Actual Hours	Year to Date Variance Hours	Year to Date Cost
59	Extra set-up result of machine break down.	N						
60	Extra work.	N						
61	Two men had to be assigned to job due to nature of job.	N						
62	Learner, apprentice, or student.	N						
63	Man inexperienced. Undergoing instructions.	N						
64	Different operators used due to difficulty of job.	C						
65	Assisting inexperienced operator on another machine.	N						
66	Man's effort and/or ability below average.	C						
67	Oper. not performed correctly. Add'l time required.	C						
68	Parts spoiled. Had to make additional parts.	C						
69	Tools not available at time job was started.	N						
70	Trying out new tools.	N						
71	Tools not correct when job was started. Had to be corrected.	N						
72	Broke tool. Time lost redressing and sharpening.	C						
73	Oversized material used.	N						
74	Castings warped, but are within Foundry tolerances.	N						
75	Castings not to dimensions. Time lost waiting for instructions.	N						
76	Material too hard. Frequent sharpening of tools required.	N						
77	Improper supervision.	C						
79	Illegible Blue Prints.	N						
80	Blowholes and porous castings	N						
81	Sheet stock—Secondary material or scrap ends used.	N						
99	Full quantity or operations not complete.	N						
	Total Losses							
	Total							
	Efficiency % Controllable by Foreman	C						
	Efficiency % Noncontrollable	N						
	Efficiency % Overall							

Fig. 6. (Continued.)

The standard labor hours for an operation are usually computed by multiplying the standard number of hours for a unit of production by the number of equivalent units of production for the period. Sometimes, however, it may be important to recognize that labor must be applied in proportion to the quantity of material worked on, rather than in proportion to the quantity of output. A **total labor efficiency variance** computed on the basis of product may then be made up of two parts: an efficiency variance because of the rate of production on materials worked on, and an efficiency variance resulting from the yield of product. An illustration may be based on the same figures for materials used in the discussion under "Mix and Yield Variances" in this section. Assume that the standard specifications for materials and labor in 10 pounds of product R are as follows:

Raw materials:		
Material A: 8 lb at $1 per lb.	$8.00	
Material X: 4½ lb. at $2 per lb.	9.00	
Mixed materials A and X: 12½ lb.		$17 00
Direct labor: 5 hr. at $2.50 per hr.		12.50

Assume that actual results for the month were as follows:

Production of product R	6,600 lb.
Material A used	4,700 lb.
Material X used	3,300 lb.
Direct labor hours	3,600

The standard number of hours worked, computed in terms of production, are $6{,}600 \times 0.5$ hr. (i.e., 5 hr for 10 lb of product), or 3,300 hr. The labor efficiency variance computed on this basis is: $(3{,}300 - 3{,}600) \times \$2.50 = -\$750.00$.

If labor has to be applied in proportion to the materials handled, however, the labor efficiency variance should be computed on the basis of the rate at which materials were processed, as follows:

Materials used	8,000 lb.
Standard direct labor hours based on materials used:	
8,000 × 5/12.5 (i.e., 5 hr for 12.5 lb of material used)	3,200 hr.
Labor efficiency variance on rate of material processing:	
(3,200 − 3,600) × $2 50	−$1,000

In addition there is a labor cost variance due to the difference between the **standard and actual yield of product.** The standard yield of 8,000 pounds of input is $8{,}000 \times 10/12.5 = 6{,}400$ lb. The labor efficiency variance from a yield different from standard is $(6{,}600 - 6{,}400) \times \$12.50/10 = +\$250.00$. The net of the unfavorable labor efficiency variance on rate of materials processing of $1,000 and the favorable labor efficiency variance on yield of $250 is an unfavorable variance of $750, as computed on the basis of production.

As Nickerson (Cost Accounting) points out in connection with a similar illustration:

> We still do not know exactly what caused either of these variances. The unfavorable efficiency variance could have been caused by the nature of the materials handled, the fact that equipment was not operating up to standard, or by slowness on the part of operating personnel. In turn, the favorable yield factor might also have been due largely to the quality of the materials handled or, in part, to the efficiency with which machinery was operating or the exercise of better than normal skill on the part of the operating personnel.

OVERHEAD VARIANCE COMPUTATIONS AND CAUSES. The difference between manufacturing overhead (or burden) incurred and standard overhead charged to production in a period is the total of overhead variances. This total variance is the result of several general causes:

1. Variance in activity from the rated capacity used for the determination of overhead rates, which may be called **volume, activity, or capacity variance.**
2. Variance of actual overhead from overhead budgeted for actual activity, which may be called **budget, spending, or cost variance.**
3. Variance of actual activity from standard activity required for the production of the period, which may be called **overhead efficiency variance.**

Volume variances may have several causes, which include:

1. Causes primarily controllable by factory management.
   a. Employees waiting for work.
   b. Avoidable machine breakdowns.
   c. Lack of operators.
   d. Lack of tools.
   e. Lack of instructions.
2. Causes primarily noncontrollable by factory management.
   a. Decrease in customer demand.
   b. Excess plant capacity.
   c. Calendar fluctuations.

Overhead budget variances may have a great variety of causes. Variance of each item of actual overhead from the amount budgeted for the actual activity may have a cause different from that for other items, but in general the variance of each item from its budgeted amount is either the result of a **cost per unit** (price) different from the standard cost per unit or a **quantity used** different from the standard. Thus supplies or other indirect materials included in overhead may have a price variance and a usage variance similar to such variances for direct materials. Likewise, indirect labor included in overhead may have a wage rate variance and a labor efficiency variance similar to such variances for direct labor.

Overhead efficiency variances result from much the same causes as do labor efficiency variances, as listed in Fig. 6.

Overhead Variance Analysis. It is possible to classify the causes of overhead variances in a variety of ways, and as a result, a variety of methods for analyzing overhead variances have been presented. A method based on the preceding classification is presented in Fig. 7. This method is described by a number of authorities. Gillespie (Cost Accounting and Control) presents a similar analysis except that the overhead rate assumed is based on expected activity rather than on normal activity, with a resulting change in the meaning of the volume variance.

The following data are assumed for one month to illustrate several methods of overhead variance analysis:

	Department A	Department B
1. Budgeted fixed (or stand-by) overhead...........	$1,000	$2,025
2. Budgeted variable overhead at normal capacity...	$1,000	$ 975
3. Standard hours at normal capacity	2,000	1,000
4. Standard fixed overhead per hour	$ 0 50	$ 2 025
5. Standard variable overhead per hour.............	$ 0.50	$ 0.975
6. Standard overhead per hour	$ 1.00	$ 3.00

	Department A	Department B
7. Standard allowed hours for actual production	2,000	800
8. Actual hours run	2,065	790
9. Actual overhead	$2,011	$2,870
10. Total flexible overhead budget allowances.		
a. For actual hours	$2,032.50	$2,795.25
b. For standard hours in product	$2,000	$2,400
c. For attained production.		
Department A (2,000 hr. = 100%)...........	$2,000	
Department B (800 hr. = 80%).............		$2,805

Volume, or Activity, Variances. The NAA Committee on Research reported in NAA Research Series No. 22 (NAA Bulletin, vol. 33) that its field study indicated that ". . . much remains to be done in practice with the problem of determining causes of and responsibility for volume variances." After commenting on procedures being used successfully in some companies to improve utilization of factory facilities, the Committee observed:

> The analysis of volume variance seems to offer opportunities to the accountant, for the field study shows it has had much less attention than have direct costs of material and labor. While the latter have undoubtedly been the more important components of total costs in some companies, increasing use of expensive equipment to achieve lower production costs makes it essential to control utilization of this equipment if the expected economies are to be realized.

As computed in Fig. 7, volume, or activity, variance is the fixed overhead attributable to the difference in hours between actual activity and normal capacity. For Department B, the standard fixed overhead per hour is $2.025, and the difference between actual hours (790) and hours at normal capacity (1,000) is 210 hours, which is 21% of the hours available ($1,000). The volume variance is then (790 − 1,000) × $2.025, which equals −$425.25, a debit or unfavorable variance. If the actual hours had been 1,100, the volume variance would have been (1,100 − 1,000) × $2.025, which equals +$202.50, a credit or favorable variance.

The significance of volume variances is dependent upon what volume is assumed to be "normal." If normal means some **average activity expected** over a period of years, no clear significance can be ascribed to volume variances. It can be said only that if actual average activity for a number of years proves to be equal to the activity assumed to be normal, net volume variances for these years will be zero.

If normal capacity means **full practical capacity,** the volume variance, as computed by the method illustrated in Fig. 7, is usually a debit variance and represents the **fixed cost of idle time.** (Small credit volume variances are possible in months when extra hours are worked beyond a capacity that is practical for continued operations.) Sometimes this volume variance is called **loss on idle time.** It should be remembered, however, that the dollar amount of such volume variance has to be interpreted in the light of a recognition of certain conventions used in the accounting for fixed costs. For example, the amount of fixed depreciation included in the overhead budget, upon which overhead rates are based, is usually determined on the original cost of the asset subject to depreciation and on some practicable (but usually only roughly accurate) assumption with regard to the proper allocation of the original cost to time periods. Therefore the cost of idle time as computed will probably be an amount different from a cost of idle

Department	(1) Standard Hours at Standard Rate	(2) Actual Hours at Standard Rate	(3) Budget for Actual Hours Worked	(4) Actual Over-head	(5) Over-all (1) − (4)	(6) Efficiency (1) − (2)	(7) Volume (2) − (3)	(8) Budget (3) − (4)
A	$2,000.00	$2,065.00	$2,032.50	$2,011.00	−$ 11.00	−$65.00	+$ 32.50	+$21.50
B	2,400.00	2,370.00	2,795.25	2,870.00	− 470.00	+ 30.00	− 425.25	− 74.75
Totals	$4,400.00	$4,435.00	$4,827.75	$4,881.00	−$481.00	−$35.00	−$392.75	−$53.25

Fig. 7. Overhead Variances.

time based on a fixed overhead budget that recognizes depreciation on present values of fixed assets, and which allocates depreciation to time periods with precision.

In circumstances in which a more accurate determination of the **cost of idle time** appears desirable, a fixed overhead rate other than the one used for charging production and analyzing unabsorbed burden, including an element for depreciation based on replacement costs, may be applied to the hours of idleness. The resulting figure will not appear in the accounts but may well have more value to management than the one based on the overhead rate used for charges to production because it comes closer to the actual loss from idleness.

For managerial analysis it may be necessary to go still one step farther in estimating the true loss from idleness. Presumably, in a successful operation, the production process generates values greater than the costs incurred in production. If so, the full loss on idle time may include the gains in product values given up by failure to produce during idleness. Values can be generated in the manufacturing process, however, only if the product can be sold. When idleness is due to lack of orders, as may be usual, true loss on idleness does not include an element of lost profit. We cannot conclude that the volume variance loss based on a practical capacity overhead rate is precisely equal to the true loss from idleness without adjustment, at least in the thinking of management, for other factors. Of course it would very seldom, if ever, be practical to introduce into the accounts such refinements in the determination of idleness losses, but it is important for management purposes to recognize the limitations of the volume variance computed on the basis of the accounts.

Volume variance is frequently due to low **production schedules** caused by lack of sales orders. This in turn may be due to such conditions as the relatively high price or low quality of the company's product compared with those of competitors, inadequate advertising, inability to deliver when customers want the product, and general business conditions. A temporary cause may be that **excess capacity** was included when the plant was built, with the thought that the added facilities would be needed in the near future. It should not be overlooked, however, that a substantial part of the activity variance loss may be due to causes subject to the control of factory management, such as poor scheduling of jobs, excessive absenteeism of workers, running short of some items of materials or supplies, breakdown of machines due to lack of proper maintenance, and inadequate supervision of workers. It is the responsibility of management to determine what causes the idle time in any given situation and to take the necessary steps to minimize it.

Calendar Variances. The determination of calendar variances may become important not because they are important in themselves but because volume variances that include the effects of calendar variances may be misleading. Calendar variances result from the differences in the normal number of working days in the months and in the usual practice of charging fixed overhead for each month in an amount equal to one-twelfth of a year. In a month in which normal capacity is other than one-twelfth of the normal capacity of the year, a volume variance will apparently result even when activity is actually at normal, unless the calendar variance is isolated.

To illustrate, assume that the standard hours for a year at normal capacity in Department B are 12,000 and that the standard hours for a particular month at normal capacity are 1,100. Under these assumptions the volume variance loss of $425.25 computed in Fig. 7 is an understatement. The correct volume variance

in hours is the difference between normal capacity for the particular month, 1,100 hours, and the actual activity, 790 hours, which is 310 hours. The volume variance loss then is (790 − 1,100) × \$2.025, which equals −\$627.75. The calendar variance in hours is the difference between the normal capacity hours for the month, 1,100, and one-twelfth of the normal capacity hours for the year, 12,000, or 100 hours, which is a little over 9% of the hours available (1,100) in this month. The credit calendar variance then is [1,100 − 1/12 × 12,000] (or 100 hours) × \$2.025, which equals \$202.50. The net of the volume variance loss and the credit calendar variance is −\$627.75 + \$202.50, which equals −\$425.25. Under these assumptions, management might be led to underrate the significance of the volume variance if it were reported at the net amount without isolating the effect of calendar variance. Management decisions should be based on the \$627.75 figure, not on the net amount of \$425.25.

Budget Variances. Variances of actual from budgeted overhead are designated by various names, including: **overhead budget variances, spending variances,** and **expense variances.** The budget variance, as determined in Fig. 7, is the difference between the overhead budget adjusted for the actual hours worked and the actual overhead. This computation is dependent upon the existence of a **flexible budget** in some form. Budget variances from adjusted **standard budgets** are more significant for control and other management purposes than are budget variances from **estimated cost** budgets. Variances from estimated costs show, in general, how far the estimate missed the actual; variances from carefully determined standard costs show how far actual expenses deviate from a goal.

In Fig. 7 the budget variance for Department B is shown to be −\$74.75, an unfavorable variance, or loss if it is assumed that the budget shows real standards. This is 9.7% of the variable burden budgeted (\$770.25) for the 790 hours actually run.

In a period in which the budget variance is large relative to the standard budget and in terms of dollars, further analysis is desirable in order to trace the causes so that appropriate action may be taken. As a first step, the overhead budget variance may be broken down into two major components, a **fixed-overhead budget variance,** sometimes called an overhead "price variance," as by Nickerson (Cost Accounting), and a **variable-overhead budget variance,** which is sometimes called the "spending variance." Nickerson explains the reason for this separation as follows:

> Since the actual costs of fixed burden are not controllable in the short run by operating personnel of productive departments, analysis of the price variance on fixed burden is not of assistance for control purposes but, once this variance has been segregated, other variances which are controllable can be more easily established. Analysis of this variance, however, can be helpful when interpreting the profit shown for a period.

A more complete analysis of budget variance may be useful for control. This may be accomplished by comparing the actual overhead incurred during the period with the overhead budget item by item. This may be desirable even though the budget variance may be small because a small budget variance may be the net result of large favorable and unfavorable overhead item variances counterbalancing one another. Such counterbalancing is less likely to result when the standards for the overhead budget are rigorous enough to make unlikely large favorable variances for individual items.

To illustrate, assume that the overhead budget of Department B for one month at a normal capacity of 1,000 hours was as follows:

DEPARTMENT B

Overhead Budget for
May at a Normal Capacity of 1,000 Direct Labor Hours

Fixed overhead.	
Depreciation	$1,000
Insurance	250
Property taxes	200
Other fixed overhead	575
Total fixed overhead	$2,025
Variable overhead.	
Indirect labor (100 hr. at $2 per hour)	$ 200
Supplies A	60
Other supplies	215
Fuel	150
Other variable overhead	350
Total variable overhead	$ 975
Total overhead	$3.000

Fig. 8 shows the analysis of the total budget variation of Department B for the month into its component parts. The fixed overhead items in the budget

DEPARTMENT B

Comparison of Actual Overhead with Budget Adjusted for Actual Hours Worked (790) and Variations from Budget

May, 19__

	Budget for 790 hr.	Actual Overhead	Budget Variations
Fixed overhead.			
Depreciation	$1,000 00	$1,000 00	$—0
Insurance	250 00	255 00	—5 00
Property taxes	200.00	200.00	—0
Other fixed overhead	575.00	575.00	—0
Total fixed overhead	$2,025.00	$2,030 00	—$ 5.00
Variable overhead.			
Indirect labor	$ 158 00	$ 178.50	—$20 50
Supplies A	47.40	62.50	— 15.10
Other supplies	169 85	180 00	— 10 15
Fuel	118.50	146 00	— 27 50
Other variable overhead	276.50	273 00	+ 3.50
Total variable overhead	$ 770 25	$ 840 00	—$69 75
Total overhead	$2,795.25	$2,870.00	—$74.75

Fig. 8. Budget variances.

adjusted for 790 hours in Fig. 8 are the same as those shown in the budget based on normal capacity. Each variable overhead item is the figure shown in this budget multiplied by 790/1,000, which is the ratio of the actual hours to the normal hours worked for the month.

Still further analysis is possible and often desirable. Each variable overhead cost item is usually a function of a **quantity used** and of **a price per unit** and may therefore be analyzed into a **usage variance** and a **price variance**. If we assume that the indirect labor cost of $178.50 for May was incurred for 85 hours at $2.10 an hour we can analyze the unfavorable indirect labor variance as follows:

Standard hours of indirect labor at normal capacity of 1,000 direct labor hours	100
Standard hours of indirect labor at 790 direct labor hours: 790/1000 × 100	79
Indirect labor efficiency variation: (79 − 85) × $2	−$ 12.00
Indirect labor wage rate variation: ($2.00 − $2.10) × 85	− 8.50
Total indirect labor cost variance (as in Fig. 8)	−$ 20.50

A similar analysis is possible for the variances for other items of variable costs, although an item such as "other supplies" shown in the budget of Fig. 8 may first have to be broken down into particular kinds of supplies.

Overhead variances should also be analyzed into those that are **controllable** and those that are **not controllable** in the short run at the departmental level. It should not be assumed, as it sometimes is, that fixed costs are always noncontrollable and variable costs are always controllable by the department manager. Price variances in variable overhead items are often not the responsibility of the operating department. In most situations it is probably true that the departmental manager cannot be held responsible for any fixed costs, but the assumption should not be made without examination.

It also should be kept in mind that the so-called **variable costs** frequently do not change in strict proportion to changes in volume of production or level of activity. Thus, if direct labor hours are used as the base and they go up 10 percent in this period over last period, it should not be expected that each item of variable cost will go up exactly 10.0 percent. There will usually be some variances because of the oversimplification of the basic assumption in the flexible budget. (For a more extended discussion of the characteristics of variable costs, see the section on Accumulation of Manufacturing Overhead.)

Effect of Maintenance on Overhead. Maintenance and repairs costs for a month may frequently show variations from costs shown in annual budgets adjusted for one month, because of the irregularity of maintenance and repair work. Heiser (Budgeting—Principles and Practice) points out that **maintenance labor** (assumed to be part of the indirect labor of a producing department) constitutes a troublesome problem in budgeting indirect labor:

> The problem is twofold, involving the determination, first, of the required amount of maintenance in relation to scheduled production and, second, the manpower necessary to its accomplishment. For short periods of time, maintenance needs may be unpredictable, but over long periods they generally are believed to have a very close relationship to volume of production. The key to successful budgeting of this cost is an experience record based on actual maintenance reporting and accounting.

In a month of high activity, there may be little time for maintenance and repair work, and actual costs may be much below the amount budgeted for this

month on either a time or activity basis. In a month of low activity, time may be available for maintenance and repair work, and actual costs for such work may be well above the amount budgeted for that month. Management should recognize this cause of variance for maintenance and repairs costs and judge the performance of the department accordingly. The conditions that reduce the significance of monthly variances in maintenance and repairs also reduce the significance of the annual variances but not to so great a degree. Over the longer time period, maintenance and repairs are more likely than in a short period to vary directly with activity or with time.

By the use of adjusting entries to charge maintenance and repairs and credit an **allowance for maintenance and repairs,** monthly charges can be made proportional either to activity or to time. Under this procedure actual expenditures for maintenance and repairs are charged to the allowance account. This procedure has the advantage of postponing the appearance of the variances until the end of the year, when the amount is more significant.

In the typical industrial plant there is dual control of maintenance. Foremen of producing and service departments have the responsibility for seeing that equipment and facilities are so used and maintained that the cost of their service is kept at a minimum. But few departments have sufficient work to justify the full time of specialized machines and repairmen; hence centralization in the form of one or more **maintenance departments** takes place under a maintenance foreman, chief electrician, or chief engineer. Such an executive is responsible for the maintenance requirements of individual departments in the most efficient and economical manner.

The problem arises as to whether costs of maintenance should be handled through a **maintenance budget** for the plant as a whole, with the maintenance foremen held responsible, or whether maintenance allowances should be included in the budgets of departments where the facilities are being serviced. Usually the latter is the preferable solution, since the maintenance foreman has little control over equipment usage and demands made upon the maintenance force are largely under control of the department foreman. If the departmental foreman is held responsible for labor and materials cost of maintenance and repair work for his department, he is more likely to see that all such expenditures are justified, and to take steps to see that usage of the equipment is such as to keep maintenance costs at a reasonable level. Accordingly it is considered best practice to include this maintenance allowance in the **flexible budgets** of the operating departments. At the same time, cost accounting procedures may need reviewing to see that they provide for direct charges for all maintenance labor and supplies against departments benefited. It may be desirable in some cases to have the foreman of the producing department approve all **time cards** and **material requisitions** where cost is chargeable against his department.

Heiser (Budgeting—Principles and Practice) says that there is a certain amount of unavoidable duplication in connection with the maintenance budget:

> Maintenance and repairs are properly placed in the budget of the particular department for the benefit of which the repair expenditure is incurred, but the maintenance department must also prepare a budget from which information will be derived as to the number of employees and repair materials needed and the probable cost.
>
> The latter budget is in the nature of a summary of the maintenance requirements of all the operating departments. Such duplication is unavoidable because both budgets are required for maintenance control, as part of the process of summarizing maintenance requirements for the payroll and personnel estimates and for the financial budget.

Analysis usually shows that **cost of maintenance** is a semi-variable cost. Some assets, such as buildings, require repair and upkeep without relation to the rate of operations, while others, such as machinery, have a maintenance cost which tends to vary directly with the rate of production. For analysis and control it is desirable that total maintenance costs be divided into labor costs and materials and supplies costs. When this is done, the effect of labor rate and price changes can be more easily reflected and interpreted. Analysis by classes or types of equipment may also be desirable, since the proportion of fixed and variable expense included in maintenance cost of different types of equipment may vary.

Seasonal Influences on Overhead. The change of seasons may bring overhead budget variances that cannot be regarded as measuring performances. **Heating, lighting,** and **air conditioning** are affected by the season. Fuel costs for heating will normally be higher in the winter than in the summer, and therefore unfavorable fuel budget variances can be expected in the winter and favorable fuel budget variances can be expected in the summer. If it is practical to refine the adjustments of the annual budget to a monthly basis by allowing different appropriate amounts for fuel for different months, this should be done to make the variances more meaningful; if it is not practical, management must expect the monthly variances to be influenced by seasonal factors over which the operating departments will have no control.

Overhead Proportional to Direct Labor Dollars. A problem sometimes arises in the interpretation of overhead budget variances because some overhead costs, such as **social security taxes,** may be proportional to direct labor dollars instead of proportional to hours of activity. A budget variance for such items may thus be caused by direct labor wage rates differing from standard and should be so recognized. Some companies prepare budgets for overhead and corresponding overhead rates on the basis of direct labor dollars instead of hours of activity. If full standard costs are used for the department concerned, the total standard charge to production and the total overhead variation will be the same as that obtained when hours were used as the basis. To the extent that it is valid to treat overhead as a function of direct labor dollars, however, the determination and analysis of the budget variances should be different The overhead budget previously illustrated for Department B would be for a normal capacity of some number of dollars (say, $2,000), and the overhead rate would be expressed as a **percentage of direct labor dollars.** In this particular case it would be 150 percent ($3,000 ÷ $2,000). The first column of the budget variance analysis shown in Fig 8 would then be headed to show the budget for the actual dollars of direct labor for the month; say, $1,600. The variable overhead cost items would then show amounts equal to 1,600/2,000 of the budgeted amounts shown for the month at a normal capacity of $2,000 of direct labor cost, instead of 700/1,000 of these amounts. The variable overhead items would, under these assumptions, be somewhat larger than those shown in Fig. 8, and the overhead budget variances by items would be correspondingly changed. If the overhead budget variance is so computed, it must be recognized that the algebraic sum of the budget variance and the volume and efficiency variances, as previously computed, will usually not be equal to the total overhead variance because the volume and efficiency variances are computed on the basis of a time instead of a direct labor dollar measurement of activity. The sum of the several overhead variances can be reconciled to the total difference between actual and standard overhead by a separate computation of the budget variance on the basis of direct labor hours. A computation of volume and efficiency variances on the basis of direct labor costs can

hardly be justified because the effect of wage rates paid for direct labor cannot properly be included in a measure of activity.

In general it can be said that most variable overhead costs vary with activity and are not directly influenced by direct labor wage rates, so that an analysis of overhead budget variances in terms of direct labor costs is usually not so satisfactory as is the analysis previously illustrated.

Overhead Efficiency Variances. An overhead efficiency variance is the standard overhead cost of the difference between actual time and standard time for the production of a period. Like labor efficiency variance, it is the result of using more or less time than standard in an operation or process. Fig. 6 indicates various possible reasons for efficiency variances.

The loss resulting from the use of more time than standard for production includes a loss from excess labor as well as a loss from excess overhead. Such losses may be the result of using a grade of labor lower than that called for by the standards and may therefore be counterbalanced by wage rate variance gains. If these variance gains exceed the efficiency variance losses, consideration should be given to the possible desirability of **standard revisions** to call for more labor at the lower wage rates. If efficiency variance gains exceed wage rate variance losses, both resulting from the use of higher quality labor, consideration should be given to revising standards to call for the higher grade of labor.

Efficiency variances may also be related to the quality of materials used and may therefore be related to **materials mix, usage,** and **price variances.** A recognition of the possible interrelationships of variances can lead to improvements in the combinations of the various factors of production used by a company. A continuing study of such interrelations may suggest further analytical studies based on mathematical techniques now being increasingly used.

In Department B, discussed with Figs. 7 and 8, the efficiency variance in hours is the difference between the actual hours (790) and the standard hours for the actual production (800). This is a favorable variance of only 1¼ percent and for this month is probably unimportant. This overhead efficiency variance in dollars is ten times the full overhead rate ($3 per hour) or + $30.

Fixed Overhead in Efficiency Variance. The overhead efficiency variance may be further analyzed into a **fixed and a variable component** by applying the fixed and variable components of the overhead rate to the number of hours variation from standard. Thus the favorable efficiency variance of $30 may be broken down as follows:

Variable overhead efficiency variance:	
	10 × $0.975 = +$ 9.75
Fixed overhead efficiency variance:	
	10 × $2.025 = + 20.25
Overhead efficiency variance =	+$30.00

Nickerson (Cost Accounting) considers the procedure of including the fixed overhead in the efficiency variance computation and defends its soundness. He reviews the arguments sometimes made against it: that fixed burden costs are not within the control of supervisors; that these costs do not change with an increase or decrease in the efficiency of labor; and that it is the workman rather than the supervisor who controls the efficiency of labor. Nickerson points out that even if the last argument were true, it still would seem advisable to compute efficiency variances to see what labor inefficiency was costing the company. He adds: "Such

a variance might also serve as a stimulus for the development of wage-incentive plans or the use of either machine-controlled speeds or more fully automatic machinery. . . . In the great majority of cases a supervisor still has some responsibility for the efficiency of those working under his direction."

Nickerson's principal argument is that a supervisor is responsible for the efficient utilization of space, equipment, and other overhead facilities and that these costs can be recouped only by the production of salable product. The burden rate represents a rental charge to the supervisor for the facilities furnished, and he is charged only for the hours worked. Nickerson states:

> With respect to fixed burden the supervisor should be held responsible only for turning out a product having a value in terms of standard cost equal to the standard cost which he has been charged for the hours worked. If he does better than this, he should be given credit for the contribution of his unit to a better-than-standard recoupment of costs. If he does more poorly he should be held responsible for any inefficiency of his unit. . . . Supervisors should periodically be given a reminder of the heavy fixed charges involved in the operation of their units. This should be done not only for the purpose of highlighting the importance of the efficient use of operating time but also as a possible stimulus to ideas for cost reduction or as a possible deterrent to unreasonable demands for additional space and facilities. This means simply that a man who knows that, in one way or another, he is going to be held accountable for a given cost is more likely to have an interest in keeping that cost at a reasonable level.

Overhead Proportional to Materials Input. As pointed out in connection with the discussion of labor variances, the **standard hours** for an operation are usually computed by multiplying the standard number of hours for a unit of production by the number of equivalent units of production for the period. Under some circumstances it may be important to recognize that hours worked are proportional to the quantity of material worked on rather than proportional to the quantity of output. A total overhead efficiency variance may then be composed of two parts: an efficiency variance because of the rate of production on materials worked on and an efficiency variance resulting from the yield of product. An illustration may be based on the figures used for product R under "Mix and Yield Variances" in this section. Assume that the standard specifications for 10 pounds of product R are as follows:

Raw materials.		
Material A: 8 lb. at $1 per lb.	$8 00	
Material X: 4½ lb. at $2 per lb.	9.00	
Mixed materials A and X: 12½ lb.		$17.00
Direct labor: 5 hr. at $2 50 per hr.		12 50
Overhead: 5 hr. at $3 per direct labor hour		15.00
Total standard costs per 10 lb. of product R		$44 50

Assume that actual results for the month were as follows:

Production of product R	6,600 lb.
Material A used	4,700 lb.
Material X used	3,300 lb.
Direct labor hours	3,600

The standard number of hours worked computed in terms of production are 6,600 × 0.5 hr., or 3,300 hr. The overhead efficiency variance computed on this basis is: (3,300 − 3,600) × $3 = −$900.

If labor has to be applied in proportion to the materials handled, however, the overhead efficiency variance should be computed on the basis of the **materials processing rate** as follows:

Materials used	8,000 lb.	
Standard direct labor hours based on materials used:		
8,000 × 5/12.5	3,200 hr.	
Overhead efficiency variance on rate of material processing:		
(3,200 − 3,600) × $3		−$1,200

In addition there is an overhead variance due to the difference between the standard and actual yield of product. The standard yield of 8,000 pounds of input is 8,000 × 10/12.5 = 6,400 lb. The overhead efficiency variance from a yield different from standard is (6,600 − 6,400) × $15/10 = +$300. The net of the unfavorable overhead efficiency variance on rate of materials processing of $1,200 and the favorable overhead efficiency variance on yield of $300 is an unfavorable variance of $900, as computed on the basis of production.

Each of these overhead efficiency variations may be analyzed into **fixed and variable components** by applying the fixed and variable overhead rates to the applicable quantity variations.

ALTERNATIVE ANALYSES OF OVERHEAD VARIANCES. Several other methods of analyzing overhead variances can be used. Figs. 9, 10, and 11 show the results of some different methods of overhead variance analysis. They are based on the data given in this section under "Overhead Variance Analysis."

Department	(1) Standard Hours in Product at Standard Rate	(2) Allowed Budget for Standard Hours in Product	(3) Actual Overhead	(4) Variances: Total (1) − (3)	(5) Variances: Capacity (1) − (2)	(6) Variances: Controllable (2) − (3)
A	$2,000	$2,000	$2,011	−$ 11	$ 0	−$11
B	2,400	2,805	2,870	− 470	− 405	− 65
Totals	$4,400	$4,805	$4,881	−$481	−$405	−$76

Fig. 9. Analysis of overhead variances; two variances.

Two-Variance Analysis of Overhead. A two-variance analysis is illustrated in Fig. 9. A **capacity variance** is computed by subtracting from the standard hours in the product at the standard rate, the budget allowance for the attained production of the period. This budget allowance is the amount of the budget total adjusted to the standard hours in the production of the period. It could also have been computed by determining the difference between the number of standard hours in production and the number of standard hours at normal capacity, and by multiplying the difference by the standard fixed overhead rate. For Department B, this would be (800 − 1,000) × $2.025, which equals −$405. Capacity variance differs from the volume variance shown in Fig. 7 because in Fig. 7 the volume variance in hours was the difference between actual, rather than stand-

Department	(1) Standard Hours at Standard Rate	(2) Allowed Budget for Standard Hours in Product	(3) Allowed Budget for Actual Hours Worked	(4) Actual Overhead	(5) Variances: Total (1) − (4)	(6) Variances: Volume (1) − (2)	(7) Variances: Efficiency (2) − (3)	(8) Variances: Budget (3) − (4)
A	\$2 000 00	\$2 000 00	\$2 032 50	\$2 011 00	−\$ 11 00	\$ 0	−\$32 50	+\$21 50
B	2,400 00	2 805 00	2 795 25	2 870 00	− 470 00	− 405 00	+ 9 75	− 74 75
Totals	\$4 400 00	\$4,805 00	\$4 827 75	\$4 881 00	−\$481 00	−\$405 00	−\$22 75	−\$53 25

Fig. 10 Analysis of overhead variances; three variances

Department	(1) Standard Hours at Standard Rate	(2) Actual Hours at Standard Rate	(3) Budget at Normal	(4) Actual Expense	(5) Variances: Over all (1) − (4)	(6) Variances: Efficiency (1) − (2)	(7) Variances: Capacity (2) − (3)	(8) Variances: Budget (3) − (4)
A	\$2 000 00	\$2 065 00	\$2 000 00	\$2 011 00	−\$ 11 00	−\$65 00	+\$ 65 00	−\$ 11 00
B	2 400 00	2 370 00	3 000 00	2 870 00	− 470 00	+ 30 00	− 630 00	+ 130 00
Totals	\$4 400 00	\$4 435 00	\$5 000 00	\$4 881 00	\$481 00	−\$35 00	−\$565 00	+\$119 00

Fig 11. Analysis of overhead variances; an alternative three-variance method.

ard, hours in the product and the standard hours at normal capacity. Which method yields the more significant figure for volume variance depends upon which measure of activity (hours or output) is more valid. If normal capacity is better measured in terms of hours rather than in terms of output, the volume variance shown in Fig. 7 is the more meaningful to management because it shows the fixed overhead costs applicable to the variance in hours of activity from normal. The capacity variance, as computed in Fig. 9, includes part of the effect of the efficiency of operations measured in hours. For Department B the efficiency variance in hours is the difference between actual hours (790) and the standard hours in the product (800), or 10 hours. The fixed component of the efficiency variance is then +10 × \$2.025, or +\$20 25, the difference between the volume variance of Fig 7, and the capacity variance of Fig. 9 [−\$425.25 − (−\$405)] = \$20.25. In many circumstances the separation of a variance due to hours of activity from that due to efficiency in production will be useful in management analysis. However, if it is valid to assume that fixed costs are noncontrollable in the short run by the department, the capacity variance shown in Fig. 9, including as it does all the fixed overhead variances, can be properly considered as a **noncontrollable variance** in contrast to the **controllable variance.**

The controllable variance of Fig. 9 is computed by subtracting the actual overhead from the allowed overhead budget for the attained production of the period. The controllable variance thus determined includes the budget variance and the variable component of the efficiency variance, as computed in Fig. 7. Presumably these variances are, at least partially, controllable by the department and may well be contrasted in a two-variance analysis with the noncontrollable "capacity" variance of Fig. 9.

Alternative Three-Variance Analysis of Overhead. For some purposes, a two-variance analysis is considered insufficient for managerial control purposes, and three variance analyses are often recommended. Lang–McFarland–Schift (Cost Accounting) suggest a method illustrated in Fig. 10. The **volume variance** is determined in the same way as the capacity variance (Fig. 9), i.e., by subtracting the allowed budget for standard hours in the attained production from the standard hours in the product at the standard rate. This variance includes the fixed component of the overhead efficiency variance.

The **efficiency variance** is computed by subtracting the allowed budget for the actual hours worked from the allowed budget for the standard hours for the attained production. This efficiency variance may also be determined by subtracting the actual hours worked from the standard hours in the product and multiplying the difference by the variable overhead rate. For Department B this computation would be as follows: (800 − 790) × \$0.975 = +\$9.75. The fixed overhead on the 10-hour efficiency variance from standard is included in the volume variance.

The **budget variance** under the method of Fig. 10 is computed in the same way, as by the method of Fig. 7, by subtracting the actual overhead from the allowed budget for the actual hours worked.

Fig. 11 illustrates a method presented by Neuner (Cost Accounting) and Blocker and Weltmer (Cost Accounting). The **efficiency variance** is computed by the method described in Fig. 7, i.e., by subtracting the actual hours at the standard rate from the standard hours at the standard rate, or by subtracting the actual hours from the standard hours for production and multiplying the difference by the standard overhead per hour (including both fixed and variable components).

Under the method of Fig. 11, the **capacity variance** is determined by subtracting the budget at normal from the actual hours at the standard rate. It may also be computed by subtracting the hours at normal capacity from the actual hours and multiplying the difference by the whole standard overhead rate. For Department B this would be computed as follows: $(790 - 1{,}000) \times \$3 = -\$630$. The capacity variance as thus computed is not the fixed overhead cost of the hours variance from normal and is subject to the objection that it includes a variable component that is of little significance to management. The variable component of the $-\$630$ capacity variance for Department B may be determined as follows: $(790 - 1{,}000) \times \$0.975 = -\$204.75$. This figure signifies only that if activity had been at normal of 1,000 hours, the variable overhead would have been \$204.75 more, according to a flexible budget.

Following the method of Fig. 11, the **budget variance** would be computed by subtracting the actual overhead from the budget at normal. This is subject to the objection, however, that this comparison is relatively insignificant for control purposes. In order to measure adequately the control by a department of its overhead, a comparison of the actual overhead with the overhead budget adjusted to actual activity is more significant. The actual overhead for a department may be considerably below the amount budgeted at normal simply because activity is below normal, even though the actual overhead may considerably exceed the amounts that the budget, adjusted for actual activity, shows as those which should have been incurred. This method of determining the budget variance is used with a **fixed budget**; in cases in which the budget is **flexible**, it should not be used. For a company with fluctuating activity, a flexible budget is almost indispensable for control purposes, and a company with a flexible budget should not determine overhead budget variation by the method of Fig. 11.

Fig. 12 is adapted from a comparison in tabular form prepared by the NAA Research Staff (NAA Bulletin, vol. 34) of a two-variance method and three different three-variance methods. The field study conducted by the NAA Research Staff in developing NAA Research Series No. 22 (NAA Bulletin, vol. 33) indicated that most companies using standard costs develop two overhead variances, usually called **controllable variance** and **volume variance**. The NAA Research Staff observed that a few companies use the less common method of developing three overhead variances. The committee commented that it appeared that the **three-variance plan** would be more useful than the two-variance analysis "only where there are frequent and important differences between actual hours and standard hours and where these differences are not more conveniently controlled by other means."

TIGHTNESS OF STANDARDS AND NECESSITY FOR COMPLETE ANALYSIS. If standards are **rigorous** or **tight**, there will usually be few large favorable variances, so that normally it may be assumed that if the total variance for a month in a department is small, there will be no very large unfavorable variances. If standards are easily attained and often bettered, a small total departmental variance may be the net result of large favorable and unfavorable variances, so that it is not safe to assume that detailed analysis is unnecessary. If "standards" are really merely **estimates of expected costs**, the analysis of a small total variance may also show large favorable and unfavorable variances, but such an analysis is relatively unimportant because variances from estimates show only how good or bad the estimates are and do not give much information useful for control. Detailed analysis, however, may serve the purpose of giving information that will serve to improve future estimates.

TABULAR SUMMARY OF OVERHEAD VARIANCE ANALYSIS METHODS

	TWO-VARIANCE METHOD	PRIMARY COMPONENTS	THREE VARIANCE METHODS Method 1	Method 2	Method 3
Total Variance (A+B+C+D)	Controllable Variance (A+B)	A—Budget Controllable Component—Actual burden dollars for month less flexible budget allowance for actual hours used for actual production in month.	First Variance (A)	First Variance (A+B)	First Variance (A)
		B—Excess Hours Controllable Component—Flexible budget allowance for actual hours used for actual production in month less flexible budget allowance for standard hours allowed for actual production in the month.	Second Variance (B)		Second Variance (B+C)
	Volume Variance (C+D)	C—Excess Hours Volume Component—Fixed component of standard burden rate times difference of actual less standard hours for actual production in the month.	Third Variance (C+D)	Second Variance (C)	
		D—Capacity Volume Component—Fixed component of standard burden rate times difference of "normal" hours for the month less actual hours for the month.		Third Variance (D)	Third Variance (D)

Fig. 12. Comparison of two-variance and three-variance analysis methods.

Reports on Variance Analyses

PURPOSE OF VARIANCE REPORTS. Henrici (Standard Costs for Manufacturing) makes some general comments which should be kept in mind in designing variance reports for operating personnel:

The presentation of variances must always be accompanied by an awareness of its ultimate use. It is easy for the statistical mentality to be beguiled into devious paths of analysis, which the lay mind cannot follow. And yet it must be remembered that all cost statements, comparisons, variances, and interpretations thereof become useful tools only in the hands of the operating executive who controls manufacturing processes. He can employ these tools only if he readily understands them. . . . It is the standard-cost accountant's duty to give him vivid reports which highlight the essentials and point out particular cost deviations and possibilities for improvement.

Henrici advises that the reports be drawn up to:

1. Show the supervisor what his costs should have been.
2. Show how closely he came to meeting those costs.
3. Show whether his performance in this respect is improving.
4. Set up a means of explaining the variances so that the knowledge of their causes can be used as a weapon for their reduction.

MATERIALS COST VARIANCE REPORTS. Cost variance reports should show a separation between price and usage variances, so that each one may be properly interpreted and so that executives may be held responsible only for those under their control.

Materials Price Variance Reports. Fig. 13 is a report of materials price variances suggested by Blocker and Weltmer (Cost Accounting). This is a form of

ANALYSIS OF MATERIAL PRICE VARIANCES

Date | Approved by | Prepared by:

Invoice Date	Purchase Order No	Voucher No.	Supplier	Material or Supply Purchased	Quantity Purchased	Actual Cost		Standard Cost		Variance		Percent Variance from Standard	Explanation of Variances
						Per Unit	Total	Per Unit	Total	Per Unit	Total		

Fig. 13. Daily materials price variance report.

daily report and contains details of the purchases that are vouchered on a single day. The report may be prepared by either the accounting or purchasing department but the column, "Explanation of variances," is filled in by the purchasing agent. This type of report should be available to the purchasing agent, cost accountant, and controller. **Summary reports,** perhaps on a monthly basis, should be prepared for production executives and top management.

Responsibility of Purchasing Department. Action of the purchasing department with respect to buying policies influences both price and usage of materials. Price is usually thought of as uncontrollable since it is largely an outside factor. Nevertheless the purchasing department can control price to some extent through efforts to obtain maximum cash discounts, quantity discounts, by placing orders in off-seasons, by spacing orders over a period of time, by entering into contract obligations, etc. To these may also be added such circumstances as use by the manufacturing department of a type of material costing more than that called for in the specifications because the purchasing department failed to maintain an adequate supply of the needed variety.

Some variances, in particular those of market price, result from changes in external circumstances over which the plant has little or no control. Hence these variances are not to be regarded primarily as indexes of personal performance by the purchasing officer, but instead as indicators of possible needs for changes in standards, in the product price, or in the kinds of materials used.

The extent to which the **purchasing agent** is responsible for price is a matter of administrative policy. Buying on basis of price alone may degenerate into speculation. It may also tie up needed working capital in large inventory items when such capital is needed for other items. Whether a purchasing agent shall be allowed discretion to buy when he considers conditions favorable must be decided on the merits of each case.

Materials Usage Variance Reports. For the most effective control, daily reports of materials quantity variances for each **manufacturing center or department** should be made available to management. Blocker and Weltmer (Cost Accounting) illustrate a report of this type, with a separate line for each class of material used in the department and a column for a statement of the cause of variance. These daily reports for each department may be supplemented by **monthly reports** which quickly give an over-all picture of what happened on materials usage during the month. In Fig. 14 Christie (NAA Bulletin, vol. 38) shows a materials usage variance work sheet used by a concrete products company. Materials usage variances are posted and summarized on this sheet, enabling the preparation of the monthly report of materials usage variance shown in Fig. 15.

The modern trend in cost reports appears to be in the direction of greater use of **quantity engineering data** as opposed to dollar cost figures. This is because standard costs are based on physical standards, and hence reports are prepared more quickly by letting the **physical standards** speak for themselves rather than by translating them into standard costs. Also, as pointed out by Lang–McFarland-Schiff (Cost Accounting), "physical quantities are likely to be more readily understood than dollar totals, especially at the operating level." Some reports show both physical quantities and dollar amounts. Such a report, issued on a weekly basis, may be supplemented by daily reports issued by the cost department to foremen, which show those items on which the actual weights used exceed standard weights allowed. A monthly report may be used to summarize the cost variances by products.

Material Variances Worksheet

Standard Cost of Materials Specified	Total	Pyramid	Cement-Bulk	Granite and Marble
Marbelite poles	$ xx	$ xx	$ xx	$ xx
Concrete poles	xx	xx		
Piling	xx	xx		
Metal poles	xx			
Transfer from raw materials to finished goods	$ xx	$ xx	$ xx	$ xx
Cages on hand not cast-end of month..	xx			
Machine shop production	xx			
Cages on hand not cast-beginning of month	(xx)			
Standard cost of materials specified....	$ xx	$ xx	$ xx	$ xx
Standard Cost of Materials Actually Used				
Beginning inventory		$ xx	$ xx	$ xx
Purchases		xx	xx	xx
		$ xx	$ xx	$ xx
Ending inventory		xx	xx	xx
		$ xx	$ xx	$ xx
Used for other than production........		xx	xx	xx
Actual usage in production............	$ xx	$ xx	$ xx	$ xx
Material usage variance	$ xx	$ xx	$ xx	$ xx
Allocation of Material Usage Variance	**Total Variance**			
Marbelite poles	$ xx	$ xx	$ xx	$ xx
Concrete poles	xx	xx		
Piling	xx	xx		
Metal poles	–			
Machine shop production............	xx			
Total usage variance	$ xx	$ xx	$ xx	$ xx
Allocation of Material Price Variance	**Total Variance**			
Marbelite poles	$ xx	$ xx	$ xx	$ xx
Concrete poles	xx	xx		
Piling	xx	xx		
Metal poles	xx			
Machine shop production	xx			
Total price variance	$ xx	$ xx	$ xx	$ xx

Fig. 14. Materials usage variances work sheet.

Material Usage Variance

	Standard Cost of Quantities Actually Used	Standard Cost of Quantities Specified	Ratio of Actual to Specified Usage	Over (under) Standard	Marbelite Poles	Concrete Poles
Pyramid	$ xx	$ xx	xx	$ xx	$ xx	$ xx
Cement-bulk	xx	xx	xx	xx	xx	
Granite and marble	xx	xx	xx	xx	xx	
Cement-bags	xx	xx	xx	xx		xx
Sand and gravel	xx	xx	xx	xx		xx
Rebar and wire	xx	xx	xx	xx	xx	xx
Steel and rough and finished purchased parts	xx	xx	xx	xx		
	$ xx	$ xx	xx	$ xx	$ xx	$ xx

Fig. 15. Monthly report of materials usage variances.

A daily materials usage report by classes of materials, showing physical units only, is illustrated in Fig. 16, taken from Matz–Curry–Frank (Cost Accounting). These authors describe this as a typical usage report. The form is used for the whole month. Each day at a specified time the cost clerk lists the day's consumption on the proper line and takes the report to the manager.

Combined Statement of Materials Price and Usage Variances. Bennett (Standard Costs: How They Serve Modern Management) presents an example of a report of both materials price and materials usage variances (Fig. 17) for a month. He points out that for the month illustrated, the total materials cost variance loss was only $625, which if viewed uncritically, could be regarded as satisfactory. The analysis presented in the report, however, shows that this relatively small variance was the net result of a price variance gain of $4,687.50 and a usage variance loss of $5,312.50. This prompted management to make a careful review of materials usage loss, which revealed some inefficient procedures. In this actual case an intensive study was made of these procedures, and as a result they were substantially improved.

DIRECT LABOR VARIANCE REPORTS. In line with the managerial "principle of exceptions," analysis of direct labor cost should center around the variances from standard. Assuming the standards to be set properly, management's concern is to attain them. Excess labor cost (i.e., above standard) indicates the existence of conditions which call for correction. The cause of such excesses must be analyzed and, if possible, removed.

Comparison of **actual labor cost** per unit for one period with that of another period, or with the standard labor cost per unit, is only the starting point in labor cost analysis. It measures total variance or excess but discloses no information concerning causes. Since labor cost is a function of two factors, wage rate and time, it follows that the excess must be quantitatively broken down in terms of these factors and so reported to management.

DAILY MATERIAL USAGE REPORT

For month of May ___ | Class of Material: Porcelain | Unit Pounds

Date	Day				Month				Year			
	Actual Usage	Standard Usage	Variance	Var., Percent	Actual Usage	Standard Usage	Variance	Var., Percent	Actual Usage	Standard Usage	Variance	Var., Percent
Bal.									1,732,552	1,546,804	−185,748	
1												
2	11,669	10,721	− 948	8 8	11,669	10,721	− 948	8 8	1,744,221	1,557,525	−186,696	12 0
3	13 333	10,780	−2 553	23 7	25 002	21,501	− 3,501	16 3	1,757,554	1,568 305	−189,249	12 1
4	15 505	10,690	−4,815	45 0	40,507	32 191	− 8,316	25 8	1,773,059	1,578,995	−194,064	12 3
5	15,505	10,421	−5 084	48 8	56,012	42,612	−13 400	31 4	1,788,564	1,589,416	−199,148	12 5
6	14 408	9,940	−4,468	44 9	70,420	52,552	17 868	34 0	1,802 972	1,599,356	−203,616	12.7
7	7,883	6,503	−1,380	21 2	78,253	59,055	−19,198	32 5	1,810 805	1,605,859	−204,946	12 8
8												
9	17,140	16,760	− 380	2 3	95,393	75 815	−19,578	25 8	1,827,945	1,622 619	−205,326	12 6
10	13,916	14,910	994	6 7	109 309	90,725	−18 584	20 5	1,841,861	1,637,529	−204,332	12.5
11	13,920	14,781	861	5 8	123,229	105 506	−17,723	16 8	1,855 781	1 652,310	−203,471	12 3
12	13,913	14,732	819	5 6	137,142	120,238	−16,904	14 1	1,869 694	1,667,042	−202,652	12.2
13	15,333	15,231	− 102	7	152,475	135,469	−17,006	12 6	1 885 027	1,682,273	−202,754	12 1
14	16 638	17,623	985	5 6	169,113	153,092	−16,021	10 5	1,901,665	1,699,896	−201,769	11.9

Fig. 16. Daily materials usage report showing physical units only.

MATERIALS VARIANCES DETAIL
(Month of January)

Price Variances

Kind	Quantity	Price: Actual	Price: Standard	Variance: Per Unit	Variance: Gain	Variance: Loss
Bar stock	143,750	$.47	$.506	$.036—	$5,175.00	
Sheet stock	56,250	.62	.628	.008—	450.00	
Maple	187,500	.045	.04	005+		$937.50
					$5,625.00	$937.50
Price variances, gain, net					$4,687.50	

Quantity Variances

	Bar Stock	Sheet Stock	Maple	Totals	
Actual quantities used	143,750	56,250	187,500		
Standard quantities:					
125,000 @ 1 lb.	125,000				
125,000 @ ½ lb.		62,500			
125,000 @ 1.55 lb.	...	...	193,750		
Unit variances, gain	...	6,250	6,250		
Unit variances, loss	18,750				
Standard price per unit	$ .506	$ .628	$ .04		
Variances, gain	...	3,925.00	250.00	$4,175.00	
Variances, loss	9,487.50	...	...	9,487.50	
Quantity variances loss, net				$5,312.50	5,312.50
Net materials variances, loss					$ 625.00

Fig. 17. Monthly report on materials price and usage variances.

The immediate **control of direct labor cost** is, in most concerns, in the hands of foremen. This requires that they be provided with reports daily or weekly to help them in keeping this element of cost within standard limits. Where the rates paid are determined by a contract with a union or by executives other than foremen, only the usage and selection of the correct grade of labor is chargeable to foremen.

Wage Rate Variance Reports. Wage rate variances are the result of a wage rate other than standard paid for the labor of a period.

Henrici (Standard Costs for Manufacturing) presents a form for wage rate reports shown in Fig. 18 (illustrative figures have been modified). This report quickly reveals upward or downward movements in the average rate of pay per hour. Thus it may be a useful guide in employment and upgrading practices in plants where employees are on individual rather than occupational rates.

LABOR RATE REPORT

Month of February, 19__

Cost Center No.	Man-Hours Actual	Man-Hours Std.	Earnings at Guaranteed Rates Actual	Earnings at Guaranteed Rates Std.	Average Rate per Hour Actual	Average Rate per Hour Std	Percent Variation of Actual from Standard Rate
101	1,000	1,200	$ 1,800	$ 2,250	$1.80	$1 875	− 4 0
102	7,200	9,000	14,400	18,000	2 00	2 00	0
103	6,000	6,000	12,000	13,500	2 00	2 25	−11 1
104	10,000	9,000	21,000	18,000	2 10	2 00	+ 5 0
Total	24,200	25,200	$49,200	$51,750	$2 033	$2 051	− 1 0

Fig. 18. Monthly labor rate report.

Labor Efficiency Variance Reports. The second cause of excess labor cost lies in the time factor and concerns the use of an excessive number of labor hours to perform a given quantity of work. Not only are the reasons more numerous than those which create labor rate variances, but they are also harder to discover and control. Consequently the bulk of labor reports is devoted to the time element.

A comparison between estimated or budgeted unit man-hours and actual unit man-hours, revealing either a gain or loss, is provided for in Fig. 19. Study of such a report may lead to an investigation of the effectiveness of labor and to a revision of labor policies. Tracing back to causes may reveal that the right man was not placed in the right job; that a foreman has failed to obtain cooperation of workers; that training and instruction of new workers was inefficient and faulty; that wage incentive plans were lacking; that labor turnover was excessive, or that various other causes listed in Fig. 6 played a part. Information thus presented and compared has a direct bearing upon individual productivity of workers under the foreman of a department. The report covers a week, but a similar report should be prepared daily.

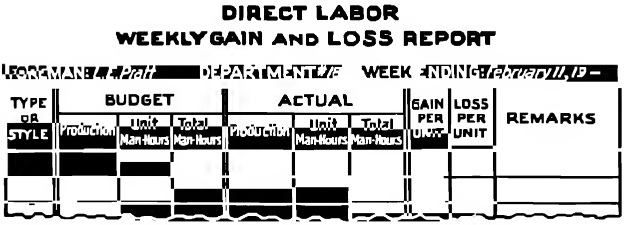


Fig. 19. Weekly gain and loss report, direct labor.

A weekly summary of direct labor variances to inform top management about the performance of departments and machine centers is illustrated in Fig. 20, from NAA Research Series No. 22 (NAA Bulletin, vol. 33). Similar summaries by jobs and by-product lines are used. These summaries are supported by a detailed report of analysis of variances by causes, illustrated in Fig. 6. Fig. 20

DEPARTMENTAL MANUFACTURING EFFICIENCY ON OPERATIONS COMPLETED

Week Ending April 29, 19– and Year to Date

DEPARTMENT	THIS WEEK					YEAR TO DATE		
	Nonstd. Hours	Actual Hours on Std.	Variance from Std. Hours	Efficiency Percent: On Controllable	Efficiency Percent: Total by Foreman	Variance from Std. Hours	Total	Controllable by Foreman
Machining:								
12 Blacksmith								
21 Auto. Screw Mach.								
22 Lathe								
24 Screw Mach.								
Total Machining								
Assembly:								
23 Inspection								
29 Painting								
43 Assembly								
46 Assembly								
48 Assembly, Electrical .								
Total Assembly								
Grand Total								

Fig. 20. Weekly summary of direct labor variances.

can also be supported by another report showing the percentage of efficiency of each individual worker.

Along somewhat similar lines Matz–Curry–Frank (Cost Accounting) suggest a **daily efficiency report** to be issued to shop superintendents to assist them in maintaining schedules that depend greatly upon high efficiency of workers in the shop. This report shows, for each group or machine center, the standard hours, actual hours, and percentage efficiency for each day and also on a cumulative basis for a week or longer period.

Loss of efficiency resulting from changes in the working force is of such significance as to call for periodic reports on **labor turnover**. The labor turnover,

calculated by dividing the total number of separations by the average number of employees, may be illustrated as follows:

Number of employees, January 1	300
Number of employees, January 31	330
Average number during January: (300 + 330) ÷ 2	315
Number of separations during January	20
Labor turnover for January (20 ÷ 315)	6.3%

An important cause of low labor efficiency is excessive delays, and **delay reports** may be important for the purpose of showing the magnitude of delays. According to Henrici (Standard Costs for Manufacturing), the delay report shown as Fig. 21, usually prepared only for incentive occupations, is valuable to

Delay Report

Date:

Cost Center No.	Total Man-Hr. on Incentive	Prod. Man-Hr.		Delay Man-Hr.							
				Maintenance		No. Materials		Other		Total	
		Amt.	Percent	Amt	Percent	Amt.	Percent	Amt.	Percent	Amt	Percent
Total											

Fig. 21. Delay report.

the standard-cost accountant for diagnosing variances and to supervisors for finding the sources of variances in order to reduce them. These reports may be issued daily, weekly, by pay period, or monthly.

OVERHEAD VARIANCE REPORTS. Because of the large number of causes and the great variety of types of overhead costs, reports of overhead cost variances take a great variety of forms. The major general types of overhead variances that should be reported are:

1. Efficiency variances.
2. Volume variances.
3. Budget variances.

Overhead Efficiency Variance Reports. Efficiency variances in hours are converted into value measurements by multiplying by a wage rate to get labor efficiency variance, or by an overhead rate to get overhead efficiency variance. If overhead rates are expressed in terms of direct labor hours, the only difference between the two efficiency variances is the result of the different rates applied

to the hours. Obviously a labor efficiency variance and a corresponding overhead efficiency variance have the same causes. This is true even if overhead rates are based on some measure of activity other than direct labor hours because different measures of activity for a department will be or should be at least approximately proportional to each other. As a result **efficiency reports** such as that shown in Fig. 6 serve to explain the causes of both labor efficiency and overhead efficiency variances. The hours of efficiency variances shown in efficiency reports may easily be converted to dollar amounts by multiplying by the appropriate rates.

Volume Variance Reports. Failure to make full use of expensive facilities characteristic of modern industry sometimes involves heavy losses both in associated fixed costs and in lost opportunities to produce. A given **volume variance loss** may be a combination resulting from a foreman's delay in providing instructions to an operator, the production control department's failure to maintain an even flow of work, and the sales department's inability to obtain enough orders to keep the factory occupied. The important thing here is for the management to ascertain what causes the **idle time** and who has the authority and responsibility to control it.

Even the part of the volume loss which arises from so-called **noncontrollable causes** must be analyzed and the responsibility must be placed, for such items may be controllable in the long run by major executives who possess authority to determine what the size of the plant and organization shall be. While estimates upon which capital outlays are based usually can be no more than opinions or even guesses, the success with which executive judgment in such matters is exercised is often a main determining factor in the long-run ability of a business to operate profitably.

The volume variance is the principal indicator of how well long-run plans concerning productive capacity turn out, since long-lived assets are largely responsible for fixed charges. Hence volume variances deserve careful analysis to determine personal responsibility and to find remedies for unfavorable conditions. Very substantial volume losses can often be reduced by such actions as improving equipment, revising layout, adding new products, or changing prices.

Vance (Theory and Technique of Cost Accounting) shows a report (Fig. 22) designed to record hours of idleness and fixed costs of idle time of a machine. These reports help foremen to assign jobs to machines that ordinarily would not handle them and would otherwise be idle. In summary form these reports aid higher executives in planning production and in assigning work to different departments. For another illustration of an **idle machine** or **machine utilization** report, see section on Manufacturing Overhead and Normal Activity.

Overhead Budget Variance Reports. NAA Research Series No. 28 (NAA Bulletin, vol. 36) states: "In order to be of service to foremen, cost reports need to focus attention on items which require prompt attention. . . . Experience of the companies interviewed indicates that variances from standard or budget constitute the most useful figures which the accountant can supply to foremen."

Fig. 23 is one of a group of four reports suggested by Patrick (The Theory and Technique of Cost Accounting in the Hosiery Industry) to show a detailed analysis of overhead budget variances. In each report the so-called **controllable costs** are separated from **noncontrollable costs**, and **common costs** are separated from **specific costs** incurred for a given division or subdivision of the company. These reports also show the loss on idleness and the overhead efficiency for the division or subdivision.

MACHINE UTILIZATION REPORT

Report No.: ______ **Section:** ______

Week Ended: ______ **Foreman:** ______

Machine	Hours Operated	Hours Idle	Hours Idle Last Week	Fixed Cost of Idle Time	Remarks
Lathe No. 1					No jobs
Lathe No. 2					Down for repairs
Shaper					No jobs
Drill Press No. 1					
Drill Press No. 2					
Drill Press No. 3					No jobs
Grinder No. 1 ..					No jobs
Grinder No. 2 ..					
Totals					

Fig. 22. Machine utilization report.

One copy of Fig. 23 goes to the person in charge of Division No. 1. The executive responsible for both Divisions No. 1 and 2 will receive a copy of the separate report for each of these divisions and, in addition, a report which combines the operations of the two divisions. A third report, on the Knitting Department, a subdivision of Division No. 1, goes to the head of that department and to the person in charge of Division No. 1. A fourth operating report at a still lower level, for a cost center in the Knitting Department, goes to the foreman of the cost center and to the head of the Knitting Department. Thus an analysis of the variances from budget at each **responsibility level** is made available to the person who is primarily responsible for taking action appropriate for cost control in the present and the future, and also to the person next above him in the chain of authority.

Reporting systems will vary from company to company as to frequency of reports, details shown, arrangement of data, persons to whom sent, and policy in regard to the size of variances requiring follow-up. The analysis of overhead costs and variances by divisions, subdivisions, departments, and cost centers should be carried out as far as the probable added cost savings in improved cost control justify the additional cost of analyzing and reporting.

DEFECTIVE PRODUCT, SPOILAGE, AND SCRAP REPORTS. These elements may constitute an appreciable loss, and one of the important responsibilities of departmental executives is to hold them to a minimum. There are two important steps in accomplishing this: (1) to analyze the **causes** of each type of loss, and (2) to take **corrective action** to eliminate or minimize each cause. The whole area of defective product, spoilage, and scrap, including reports for control purposes, is discussed in the section on Materials.

VARIANCE SUMMARY REPORTS. Some of the summarized reports which it is the duty of the cost accountant to prepare show, among other things,

DIVISION No. 1

OPERATING REPORT

Budgeted machine hours	1,010,305	Dozen pairs knit	556,554
Actual machine hours	1,011,100	Pounds of material received	800,000
Excess machine hours	795		

Cost Classification	Budget	Actual	Current Period Expense Variation (Loss)	Gain
Controllable Costs				
Indirect Labor				
Foremen's salaries	$ 22,600	$ 22,800	($ 200)	–
Yarn purchasing agent salary	5,000	5,000	–	–
Helpers' wages	12,000	11,300	–	$ 700
Clerical salaries	4,220	4,400	(180)	–
Fixing wages	72,000	71,700	–	300
Style changing wages	25,000	24,900	–	100
Mending wages	2,880	2,880	–	–
Special wages for taking inventory	1,000	1,200	(200)	–
Total	$144,700	$144,180	($ 580)	$1,100
Other Controllable Costs				
Machine needles	$ 23,543	$ 24,400	($ 857)	–
Machine parts	34,800	34,500	–	$ 300
Payroll taxes	11,420	11,555	(135)	–
Vacations cost	11,400	10,950	–	450
Miscellaneous supplies	9,020	10,400	(1,380)	–
Light tubes and fixtures	790	930	(140)	–
Travel	2,750	2,130	–	620
Total	$ 93,723	$ 94,865	($ 2,512)	$1,370
Noncontrollable Costs				
Depreciation on Equipment	$ 79,533	$ 79,533	–	–
Plant Common Costs				
Pro Rata Share	$118,889	$123,317	($ 4,428)	–
Grand Total	$436,845	$441,895	($ 7,520)	$2,470
Variation Gain			2,470	
Net Variation Loss			($ 5,050)	
Loss on Idleness			(70,311)	
Burden Efficiency Variation Knitting Department			(224)	
Total Burden Loss, Division No. 1			($75,585)	

Fig. 23. Divisional operating report.

Comparative Profit and Loss Statement

Year Ending ____________

	April — This Month	April — To Date	Budget to Date
Sales			
Product A			
Product B			
Product C			
Total sales			
Deductions			
Product A			
Product B			
Product C			
Total deductions			
Net sales			
Cost of sales			
Product A			
Product B			
Product C			
Commercial			
Standard cost of sales			
Operating profit anticipated			
Cost variances			
Material			
Labor			
Burden			
Commercial			
Total cost variances			
Operating profit realized			
Other income			
Cash discounts received			
Interest received			
Sundry sales and income			
Net on sale of capital assets			
Operating profit and other income			
Other charges			
Interest paid			
Cash discounts allowed			
Taxes on income			
Idle plant cost			
Net profit			

Fig. 24. Comparative profit and loss statement using standard costs.

summarized variances of actual from standard costs. These reports reveal in a general way the costs that are out of line and which therefore require further investigation. The more detailed reports must be examined to discover the reasons for the variances shown in the summarized statements.

Summary Reports to General Executives. The Income Statement prepared for the executives should show in a condensed form the variances from standard costs for the period covered. Figs. 24 and 25 are forms suggested by Bennett

PROFIT AND LOSS STATEMENT BY PRODUCTS

Month of ________

		Product		
	Total	A	B	C
Sales	____	____	____	____
Less:				
Returns and allowances				
Commissions	____	____	____	____
Total deductions	____	____	____	____
Net sales	____	____	____	____
Cost of sales, manufacturing	____	____	____	____
Gross profit anticipated				
Cost of sales, commercial	____	____	____	____
Operating profit anticipated	____	____	____	____
Cost variances				
Material				
Labor				
Burden				
Commercial	____			
Total variances	____			
Operating profit, actual				
Other income	____			
Other charges	____			
Net profit: this month				
to date				
budget	====			

Fig. 25. Profit and loss statement by product classes using standard costs.

(Standard Costs: How They Serve Management) for the **Income Statement.** In these illustrations cost variances are added or deducted from the **anticipated net profit,** which is the difference between the actual net sales and the standard manufacturing and commercial costs. In Fig. 25 these cost variances are not distributed to classes of products; according to Bennett this procedure is consistent with "the theory that the standard costs are the real costs, and that the cost variances are over-all differences between the results as anticipated and the actual results."

COST STATEMENT
NO X 8 (PAGE 2)
DATE FEBRUARY, 19—
DIV SAN FRANCISCO

Analysis of Operating Cost Variances
(CURRENT MONTH)

NO	OPERATING DEPARTMENTS	DIRECT LABOR BUDGET VARIANCES: MISC	NONPRODUCTIVE	PREMIUM EXCESS	RETRO PAY	ALLOWED HOUR VARIANCE	INDIRECT LABOR VARIANCE	OVERTIME PENALTY	PAYROLL EXPENSES	TOTAL LABOR VARIANCE	OTHER CONTROLLABLE: ALLOWED HOUR	OTHER	TOTAL OPERATING VARIANCES
10	Raw Mat'l Hdlg. & Stg.	597		237			120	42	11	1,007		1,344	2,351
15	Beaters & Jordans	38					64	344	(113)	333		(975)	(642)
16	No. 1 Board Machine	46	(2)				(195)	34	(98)	(215)	3,205	(591)	2,399
17	No. 2 Board Machine	(195)	110				(209)	(98)	(83)	(475)	2,086	(980)	631
18	No. 3 Board Machine	(327)	66				(65)	68	(95)	(353)	641	1,858	2,146
20	Sheet Liner	(14)	(71)	4				51	(11)	(41)	39	10	8
22	Boardmill Finishing	427		(17)			81	224	56	771		371	1,142
23	Corr. Waste Baler	(45)		14				62	(4)	27		200	227
24	Carton Waste Baler	(40)		22				38	(3)	17		226	243
34	Paste Making	11						12	(2)	21		(7)	14
36	Paster	(69)	52	3				20	(11)	(5)		1,510	1,505
37	Corrugators	(2)	(191)	(688)			(226)	433	(146)	(820)	3,147	(949)	1,378
39	Corrugated Case	(179)	(197)	98	(369)		(951)	724	(364)	(1,238)		(972)	(2,210)
40	Laminator	(1)	(17)	(2)			(98)	34	(15)	(99)		(125)	(224)
41	Carton	665	(787)	(365)	(384)	(2,054)	(2,174)	2,489	(524)	(3,134)	(711)	(6,007)	(9,852)
42	Egg Filler	(171)	(11)	28			(134)	(16)	(50)	(354)	70	(143)	(427)
70	Shipping & Warehousing	(269)		220				86	(68)	(31)		1,196	1,165
		472	(1,048)	(446)	(753)	(2,054)	(3,787)	4,547	(1,520)	(4,589)	8,477	(4,034)	(146)

NOTE BRACKETS OR RED DENOTE LOSS

EXPLANATION OF SIGNIFICANT VARIANCES

Direct Labor - Nonproductive Variance - $(1,048)

Carton Dept - $(787)

Training program in the die making room accounts for $(520)

Excessive proportion on nonproductive time to total time was experienced on the gluers due to curtailed running schedules from three shifts to two shifts with no change in daily and weekly cleanup time. This accounts for $(77)

Allowed Hour Variance - $(2,054)

Too light scoring on cutting operation caused excessive reoperation costs of $(1,287).

Indirect Labor - $(3,787)

Carton Dept. - $(2,174)

The addition of three inspectors to the printing centers accounts for $(1,692).

( ) Denotes red figures

Fig. 26. Summary of controllable operating variances by department.

			COST STATEMENT NO. X-6 (PAGE 1) DATE Feb. 19— . DIV. San Francisco	
		Summary of Cost Variances		
CURRENT MONTH		DESCRIPTION	YEAR TO DATE	
AMOUNT	% OF STD.		AMOUNT	% OF STD.
		681 Operating Variances		
(4,589)		1 Direct Labor—Operating (Analysis on page 2)	(39,141)	
(4,034)		2 Other Controllable Costs (Analysis on page 2)	(45,376)	
8,477		3 Allowed Hour Variation (Analysis on page 2)	37,393	
(146)			(47,124)	
		682 Service Department Variances		
(2,483)		1 Controllable Cost Variance (Analysis on page 3)	(12,238)	
(1,976)		683 Volume Variance		
		1 Volume Variance (Analysis on page 3)	30,935	
		684 Material Variances (Analysis on page 3)		
(1,016)		1 Material Price	(12,309)	
(535)		2 Material Usage	11,795	
(1,551)			(514)	
		685 Other Manufacturing Variances		
5,893		1 Carton Department Waste (Credit)	50,579	
		2		
(2,719)		3 Loss on Defective Finished Merchandise (Per Schedule)	(16,243)	
3,174			34,336	
		687 Inventory Adjustments		
		1 Adjustment to Physical		
(242)		2 Revaluation to Market	(242)	
		3 Reclassification of Products	(1,372)	
(242)			(1,614)	
		689 Miscellaneous Cost Adjustments		
5		1 Fixed Costs (Over) or Under Budget	(8,528)	
(5,316)		2 Over or (Under) Absorbed Service Costs	(28,002)	
(399)		3 Use of Assumed Standard Product Cost	6,139	
453		4 Sale of Scrap and Junk	4,416	
(966)		5 Experimental Expense	(1,094)	
		6 Recoveries or Gains on Insurance Claims	170	
(1,096)		7 Sales and Use Taxes on Capital Additions	(13,272)	
		9 Other Miscellaneous Cost Adjustments: (Specify in detail)		
503			3,230	
2,054		6812) Deduct: Allowed Hour Variation Transferred	36,338	
711		6813) to Inventory	17,413	
(4,051)			16,810	
(7,275)		TOTAL COST VARIANCES	20,591	
		NOTE: BRACKETS OR RED DENOTE LOSS		

Fig. 27. Summary of operating cost variances of plant.

Plant Summary of Variances. NAA Research Series No. 22 (NAA Bulletin, vol. 33) gives Fig. 26 as an illustration of a summary of **controllable operating variances** for each department in a plant. Fig. 27 then summarizes all the cost variances of the plant in one statement. It should be noted that each variance on the plant summary is supported by an analysis on another page (not shown). A copy of both the reports illustrated is sent to the home office, and from these a statement is prepared for the president and board of directors.

Summarized Efficiency Cost Report

Month Ending December 31, 19__

	Dept. 1	Dept. 2	Dept. 3	Total
Manufacturing costs				
Total actual costs for month.	$15,275.00	$18,712.50	$13.319.75	$47,307.25
Engineering standard costs..	13,281.25	17.658 25	12.550.30	43,489.30
Net increase* or decrease..	$ 1,993.75*	$ 1,054.25*	$ 769.45*	$ 3,817.45*
Analysis of Causes of Variances from Standard Costs				Increase * Decrease
1. Losses due to variances in direct labor costs				
a. Change in wages......				
b. Idle time of operators				
c. Inefficiency of operators				
	419.25*	311 25*	165.50*	896.00*
2. Losses due to variances in indirect labor costs				
a. Change in wages......				
b. Extra time and overtime				
	95 50*	15.00*	18.50	129 00*
3 Losses due to variances in materials and supplies				
a. Change in prices of materials				
b. Change in materials used				
c. Change in handling and storage				
	417.00*	100 00	160.00*	477.00*
4 Losses due to variances in power costs				
a. Change in wages......				
b. Change in fuel and water costs............				
c. Change in transmission costs				
d. Change in power overhead				
	150 00*	152 50*	61 85*	364.35*
5. Losses due to variance in fixed costs				
a. Variances in dept. burden				
b. Variances in gen. factory burden				
	487 00*	460 50*	299.50*	1,247.00*
6. Misc. factory expenses				
Spoiled work			64 10*	704 10*
Total All Departments..	$ 1,993.75*	$ 1,054 25*	$ 769 45*	$ 3,817 45*

Fig. 28. Statement showing variance of actual production costs from standard costs, by items and by departments.

A somewhat different form of summary report is shown in Fig. 28. This presents on one sheet the loss caused by each of the several different factors responsible for variances.

POSSIBLE SHORTCOMINGS OF STANDARD COST SYSTEMS. Standard costs provide management with one of the most effective tools yet devised for controlling costs. A standard cost system, however, is not a substitute for good management but merely an aid to management. A standard cost system works only when management, including the accountants, make it work. According to NAA Research Series No. 12 (NAA Bulletin, vol. 29), there are certain factors which can stand in the way of the successful use of standard costs if management is not careful. The following are adapted from this report:

1. Management may be uninterested or unaware of the usefulness of standard costs and therefore may make little use of them
2. The standards may become out of date or unreliable and therefore may not be taken seriously.
3. The standard cost system may be designed to give product costs rather than operation costs, with the result that variances cannot be traced to their sources without laborious investigation. This investigation may take so long that the results when determined are no longer of interest.
4. Reports may not be prepared in terms which nonaccountants can understand

Companies which have avoided these pitfalls agree almost without exception that standard costs are a most useful and effective control tool.

SECTION 18

COST-VOLUME-PROFIT RELATIONSHIPS

CONTENTS

CONTENTS (*Continued*)

SECTION 18

COST-VOLUME-PROFIT RELATIONSHIPS

Essentials of Cost-Volume-Profit Relationships

DEFINITION. Kohler (A Dictionary for Accountants) defines the cost-volume-profit relationship as follows:

> The area of interest, within an organization, of management and accountants in observing and controlling the relations between prospective and actual manufacturing costs—both fixed and variable—rates of production, and gross profits. Break-even charts epitomize these relationships at planning and forecasting stages, and various types of comparative cost statements provide information and the basis for action at operating, review, and reporting levels.

DETERMINANTS OF PROFIT. Net profit is the final reflection of a wide variety of internal and external conditions exerting their influence on revenues and on costs. **Revenues** depend on market demand, competitive conditions, and the seller's pricing and distribution policies. **Costs** are affected by many factors, including aggregate volume, direction and amount of changes in volume, product mix, territory mix, sale price and cost price, lot size, order size, plant size, and internal efficiency. The amount of cost charged as **expense** during any accounting period is also influenced by inventory accounting methods in use (for example, LIFO or FIFO, direct or absorption costing).

No one of these factors can be singled out as most important, but one of them, **volume,** deserves special attention. Changes in volume tend to be more frequent, take place more rapidly, and are less subject to management control than changes in most other cost-determining factors. Perhaps even more important, costs seldom vary in direct proportion to volume, and therefore small changes in volume have a more than proportionate effect on profits, whereas changes in other factors such as average lot size are likely to have less dramatic effects.

Both manufacturing and nonmanufacturing costs and production and sales volume are significant in the analysis of cost-volume-profit relationships. Lang-McFarland-Schiff (Cost Accounting) point out that

> . . . some manufacturing costs vary with volume of goods produced while other costs are fixed and do not rise and fall in total amount with ordinary changes in production volume. Selling and administrative costs behave similarly under conditions of fluctuating sales volume, although the proportion of fixed costs is often larger than with manufacturing costs.

In discussing the methods of analysis of costs into their fixed and variable components, they emphasize that:

> . . . These techniques must be applied to both manufacturing costs and nonmanufacturing costs (i.e., costs of marketing the products and costs of general administra-

tion). In other words, all costs deducted from sales income to arrive at operating profit are analyzed into fixed and variable portions.

OBJECTIVES OF COST-VOLUME-PROFIT ANALYSIS. Analysis of cost-volume-profit relationships is useful for a number of purposes. In NAA Research Series No. 17 (NAA Bulletin, vol. 31) the NAA Committee on Research stated: "The cost-volume-profit analysis appears to be useful principally as a technique for the study of problems encountered in business planning. As such, it is a tool used largely by those executives responsible for strategic planning and policy making."

For example, **forecasts** of profits and cash flows require knowledge of how costs and profits vary with volume. Familiarity with these relationships also makes it possible to adjust forecasts quickly when volume deviates from the original forecast. Forecasts are useful in planning and budgeting, and they may also influence management's attitudes toward cost control and appropriation-type budgets.

Heiser (Budgeting—Principles and Practice) writes that, "The most significant single factor in **profit planning** of the average business is the relationship between volume of business, costs, and profit." **Future planning** is primarily a process of selecting one out of many alternative programs that seems to promise the most advantageous combination of revenues, costs, and risks. **Development planning** relates to the selection of broad-gage programs for the company's future, usually extending one or more years ahead. This produces long-range plans and forecasts but seldom necessitates fixed commitments. **Executive planning,** on the other hand, operates within the framework of the development plan and is concerned with selection of the best current means of achieving or bettering the long-range plan. Product emphasis, make or buy, equipment replacement, and distribution methods problems are examples of executive planning. For both development and executive planning, management needs estimates of costs and revenues at the volumes associated with alternative courses of action.

One phase of executive planning is the development of **control budgets.** Budgeted revenues and costs depend on budgeted volume and must be based on analysis of cost-volume-profit relationships. Plans change as conditions change, however, and **flexible budgets** drawn up to show how costs should vary with volume are necessary tools to adapt control plans to changing conditions (see section on Cost Control, Budgets, and Reports). The cost functions for this purpose may be different from those useful in planning and forecasting. For control, standards should be based on the most efficient use of available resources; in forecasting and planning, the possibility of off-standard performance must be considered.

Knowledge of cost-volume-profit relationships is also useful in **reviewing performance.** Because operating costs and profits depend on volume, volume effects must be considered in the review of costs and profits achieved. The flexible budget for manufacturing costs and cost-volume functions for selling and administrative activities provide standards for part of this analysis. In addition the dynamic effects on costs of a change in volume need to be evaluated. **Time lags** and the **direction of change** affect the behavior of operating costs and profits.

Product pricing also requires familiarity with cost behavior. Pricing can be used to influence volume, not only during periods of idle capacity but also on the average over longer intervals of time. An intelligent pricing policy must evaluate the effect on costs of various alternative price structures. (See section on Special Cost Analyses for a discussion of pricing.)

Finally, the costing of inventory and of goods sold under absorption costing requires the use of predetermined **burden rates** at a selected volume of production (see section on Manufacturing Overhead and Product Cost, and section on Manufacturing Overhead and Normal Capacity). Studies of cost variations are necessary to determine the amount of manufacturing overhead cost that should be included in product cost for these purposes.

COST VARIABILITY TERMS AND CONCEPTS. Operating costs may be conceived of as fixed or variable with respect to volume. These terms refer by common consent to **total costs**. Only confusion results when the terms are applied to **unit costs** because this reverses their meaning. To illustrate, in Fig. 1

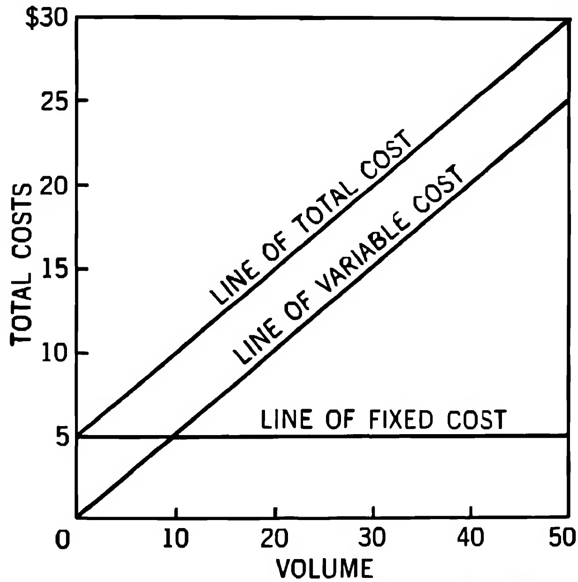


Fig. 1. Graph of total fixed and variable costs.

fixed cost is shown as a constant, but on the unit cost curve of Fig. 2, the constant item is the line of variable unit cost. Because fixed costs decrease per unit at each volume point but never reach zero at either end, the line of total cost in Fig. 2 takes the form of a hyperbolic curve. For most analytical purposes, however, fixed and variable costs are classified on the total basis, as in Fig. 1.

Underlying Assumptions. Classification of costs into fixed and variable categories is possible only when the **time period** to which these concepts relate is specified. If a sufficiently long time period is provided, almost all costs become variable through changes in the scale of the company's operations. For most cost variance studies, however, the time period used is generally a year or less. This definition is necessary because cost variance studies must specify the facilities to be used, materials prices, wage rates, and the prices of purchased services. Cost-volume analysis, in other words, relates generally to a **fixed physical capacity** situation.

The fixed-variable distinction is generally also based on the assumption that volume will move within certain relatively narrow limits (for example, between

50 percent and 90 percent of capacity) because movements outside this range would be accompanied by changes in the so-called fixed costs.

It is also assumed that all variable factors other than volume remain constant during the period to which the variability function applies. This means that in estimating cost variability from historical data, adjustments must be made to remove as much as possible of the effects of changes in product mix, prices, and methods.

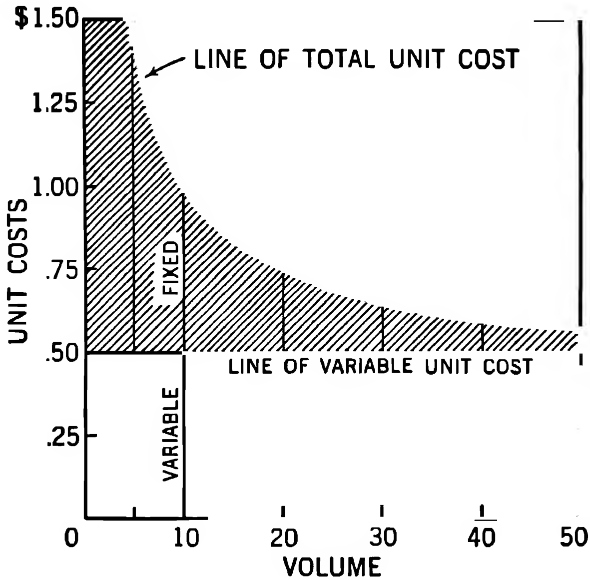


Fig. 2. Graph of fixed and variable costs on a unit cost basis.

Fixed Costs. The operation of a business requires facilities and an organization that must be maintained more or less regardless of volume. This requirement gives rise to fixed costs, sometimes called **capacity or stand-by costs.** The term "stand-by" cost in some cases is restricted to those costs that would be incurred if an operation were to be shut down completely, but the more general usage is to treat the three terms as interchangeable.

A cost is classified as fixed if a change in volume does not necessitate a change in that cost element. Fixed costs are costs of time because they accumulate with the passage of time irrespective of the volume of output. They are of three basic types:

1. Costs not susceptible to substantial change within a short period, say, a year (for example, depreciation and other sunk costs).
2. Costs fixed for short periods in terms of providing capacity to do business but susceptible to change if volume changes appear likely to continue (for example, supervision).
3. Costs fixed by management decision and bearing no necessary functional relationship to current volume of output (for example, design engineering).

Although, in a sense, all fixed costs are the result of management decisions, costs in the third category have no causal connection with the amount of business

actually being done. Wyer (NAA Bulletin, vol. 38) objects to calling them "fixed" on the ground that, "a cost cannot be fixed in relation to volume if it has no relationship in the first place." Most costs in this category are covered by appropriation-type budgets. Many are incurred to obtain future sales; for example, some kinds of advertising, research, and product development. Others are incurred to maintain a current position or to facilitate current managerial activity; for example, legal services and market research. Some do, in fact, vary with the volume of activity because management appropriates funds on the basis of anticipated sales volume, but this variance is the result of management policy rather than a functional relationship between cost and volume, and thus it does not constitute a factor of variability in any real sense.

Variable Costs. If a change in volume forces a change in the amount of a particular cost element, then that element is said to be a variable cost. Variable costs are related to volume and increase as volume increases. Commissions to salesmen, direct manufacturing materials, and social security taxes are examples of variable costs.

Cost variability in response to changes in volume is not necessarily automatic. The variability of some cost elements is subject to time lags; for others, control efforts are necessary to adjust costs promptly to a reduction in volume. For these reasons flexible budgets frequently specify the costs that should prevail at various activity levels if those levels are to be sustained long enough to permit smooth adjustment. This means that **budget standards** do not always represent the amount of cost that management expects or desires under all circumstances. The purpose of standards of this kind is to highlight deviations from the most desirable cost structure so that they can be analyzed as to cause and so that a positive decision can be made whether to continue the deviations or adjust cost structures to the new level of operations. NAA Research Series No. 16 (NAA Bulletin, vol. 30) cites as an example of this the practice of keeping employees on the payroll through temporary periods of low volume. Standard accounting treatment is to charge idle time costs of this kind to an overhead cost account which "brings to the attention of management the amount of additional cost which results from the decision not to control labor cost more closely with volume."

Recent developments in production techniques and employment practices suggest that **factory direct labor,** which has generally been classed as a variable cost, is increasingly assuming many of the characteristics of a fixed cost. In addition to employment stabilizing devices, increased mechanization and automation are cited by NAA Research Series No. 32 (Accounting for Labor Costs and Labor-Related Costs) as a development that may reduce the variability of labor costs in response to changes in the volume of output.

Semi-variable Costs. Some elements of cost are part way between fixed and variable and may be conceived as consisting of fixed and variable components. These cost elements are called by many names, such as **fixed-variable, partly variable, semi-fixed,** or **semi-variable costs.** Examples include such items as factory supervision, power, maintenance, and accounting services.

Many semi-variable costs occur because the relationship between cost and volume is not regular but rather takes the form of a **step function.** Many cost-volume studies either ignore step functions by treating such cost elements as wholly fixed, or average them out, thus regarding these cost elements as wholly variable. The method used should depend on the purpose of the study. For

example, the flexible budget frequently shows some costs going up in steps, whereas analysis of changes in product mix with the over-all level of volume unchanged generally treats step-function costs as fixed. Whenever large differentials in the volume of operations are under consideration, however, it may be desirable to treat all except the zero volume stand-by component of these step-function costs as variable with the level of volume.

Straight-Line Assumption. The cost-volume relationship is usually portrayed as a straight-line function of volume, sometimes modified by superimposing step functions. To put it another way, variable cost per unit is regarded as constant for all ranges of volume. This stems from a number of reasons, perhaps the most important being the lack of evidence that any other mathematical relationship will paint a more accurate picture. More positively for cost control purposes, unit variable cost is assumed to be constant, however, so that any deviations will be highlighted and subjected to analysis.

Wyer (NAA Bulletin, vol. 38) voices strong objections to the linearity assumption because so many factors accompany volume changes that costs should not be expected to vary in a linear relationship with volume and advises:

> Eliminate fixed and directly variable rates from your budget if you cover a broad capacity range. Guide thinking toward the amount of expenses at a given volume level or for a given time period and stop giving your operation a "license to steal" at higher volumes.

In most instances, however, the use of fixed amounts, step functions, and variable rates, despite their shortcomings, is a useful short cut which facilitates cost reporting and forecasting without seriously distorting the facts. It is hard to conceive of a workable standard cost, flexible budget control system that would discard these techniques entirely. (For further discussion see "Limitations of Usefulness of Variable and Fixed Costs" in section on Accumulation of Manufacturing Overhead.)

Measuring Cost-Volume Relationships

SELECTING THE INDEX OF VOLUME. Selection of a volume index for a single cost element (say, indirect materials and supplies) in a single department may be relatively easy, but choosing an aggregate index for all costs of the department is more difficult. For example, many costs, such as payroll taxes, are most closely related to labor dollars, whereas other costs, such as motive power, are more closely related to productive machine hours. For some purposes, however, such as the preparation of break-even charts, a **single volume index** covering a complex of costs must be chosen.

NAA Research Series No. 16 (NAA Bulletin, vol. 30) suggests four factors to consider in selecting a unit to measure volume (see section on Accumulation of Manufacturing Overhead). To obtain the maximum benefits from a cost-volume-profit analysis, the considerations discussed in subsequent paragraphs should be weighed in choosing the index of volume.

Production vs. Sales Indexes. Some costs vary with production, some vary with sales, while still others are a function of some other activity. The purpose of the analysis will normally specify which of these indexes is appropriate. In budgeting, for example, variable selling costs should be budgeted on the basis of planned sales and variable manufacturing costs on the basis of planned production. For most types of **profitability analysis,** however, production and sales

can ordinarily be assumed to be equal. For example, in studying the profitability of a specific product, it is usually sufficient to determine cost variability of sales-connected costs with respect to sales volume and production-connected costs with respect to production volume and add the two for identical volumes.

Input vs. Output Indexes. The measure of volume may be an **input index,** such as direct labor hours, or an **output index,** such as units of product. If the cost-volume relationship refers to a single product, volume may be adequately represented by the number of physical units of that product. If the product line consists of a series of products, closely related to each other but differing slightly in size or materials specifications, it may be possible to weight the various items in the product line and express volume in terms of some kind of **composite index.** For more complex product lines no satisfactory output index can be found, and an input index is necessary. An input index is also customary as a measure of the volume of operations in individual departments or cost centers.

Dollar vs. Physical Indexes. The index may be expressed in either physical or dollar terms. Dollar indexes are most frequently used in connection with break-even charts, and physical unit indexes are most common in flexible budgets for the control of manufacturing costs. Physical unit indexes are to be preferred in general because they are less subject to distortion by price changes. **Standard physical inputs** probably provide a better measure of activity than actual inputs if the cost that is being related to volume is likely to vary in proportion to the volume of output rather than to the quantities of input. For convenience these physical inputs could be priced at some standard price per unit as long as this price is held constant for all ranges of volume.

Composite Index for Flexible Budgets. In order to prepare flexible budgets, it is necessary to pick some over-all index and then attempt to correlate this with other indexes that influence various components of the budget. If **standard direct labor hours** are used, the number of machine hours, production lots, horsepower hours, or working days per month that are usually associated with each number of standard direct labor hours must be estimated. Then, for each level of the flexible budget, the amount of each cost item can be estimated on the basis of the most closely related activity index. The composite index is selected primarily for convenience of expression; the amounts budgeted are valid only for the specified combination of factors, and the analysis of cost variances must evaluate the effects of off-standard combinations of these factors.

ESTIMATING COST VARIABILITY. In NAA Research Series No. 16 (NAA Bulletin, vol. 30) the NAA Committee on Research describes three general approaches to the measurement of cost variance with volume: (1) **inspection of the company's chart of accounts,** to designate costs as fixed or variable according to type; (2) **statistical analysis of past costs,** to determine how they varied with volume; and (3) **industrial engineering analyses,** to determine how costs should vary with volume, including systematic studies of materials, labor, and the various elements of manufacturing overhead needed at different levels of production. These three approaches are typically used together, and no one approach can be said to be fully superior to the other two.

Account Classification. Careful inspection of the chart of accounts for a given organization unit will cut down the amount of work by eliminating at the outset large portions of the total cost as either wholly fixed or variable in direct proportion to volume. Labeling a cost element as wholly fixed or as variable in a

specified relation to volume requires the exercise of judgment and cannot be regarded as infallible. The main criterion should be whether there is a large enough variable element in a cost that can be classified as fixed, or whether there is a large enough fixed element in a cost that can be classified as wholly variable, to warrant expending more effort in order to determine its constituents.

This inspection of the chart of accounts will be made easier if the cost element classification embodied therein was prepared initially with the fixed-variable distinction in mind. In some cases it is possible to design **account classifications** so that fixed and variable costs are recorded separately. The limitations of this possibility are apparent and are the same limitations that restrict the use of the inspection method to the first stage in the cost variability analysis. Any cost element or account classification which cannot be identified as fixed or variable by inspection should be studied separately by either or both of the other two methods of cost analysis.

Statistical Analysis of Historical Data. Statistical analysis of past experience utilizes various correlation techniques to isolate cost variability. (These techniques are illustrated in the section on Accumulation of Manufacturing Overhead.) The existence of a correlation between cost and volume variances does not necessarily mean that a cause-and-effect relationship exists. Management policy may dictate that one or more cost elements (for example, advertising and maintenance) vary directly with volume even though there is no indication that changes in volume cause changes in the cost in a technical sense. In the case of advertising, for example, any causation will be from cost to volume rather than the other way around. This means that the results of a **correlation analysis** must be interpreted with care, or to be more specific, correlation should not be sought unless there is a strong advance presumption that a cause-and-effect relationship does exist. For costs that are set by management policy, statistical techniques are inappropriate, and management should be consulted in order to determine the appropriate allowances for budgeting purposes. Such costs should be regarded as fixed, however, in short-run cost-volume studies on which alternative choice decisions are to be based.

Cost-volume relationships should reflect the effect on cost of changes in volume, free of the distorting effects of changes in other cost-determining factors. Insofar as these relationships are based on historical data, these data must be modified to remove the effect of nonvolume influences. The section on the Accumulation of Manufacturing Overhead lists seven **nonvolume factors** which impose limitations on the usefulness of the segregation into fixed and variable elements.

Industrial Engineering Estimates. Statistical determination of cost-volume relationships from historical data is limited both by the nature of the data and by the dynamic conditions under which business must operate. Because historical data reflect the effect on cost of a multitude of influences which cannot be isolated satisfactorily, the underlying relationships between cost and volume will appear imperfectly in any analysis based solely on these data. Furthermore, the changing **business climate** means that conditions prevailing during any period in the past may provide a very poor guide to conditions in the future. Under these circumstances the best estimates of cost variability will very likely come from industrial engineering studies of materials, labor, services, and facilities needed at various volumes.

Wyer (NAA Bulletin, vol. 38) would rely almost entirely on the engineering or synthetic method of cost estimation. Dean, on the other hand, would use

engineering methods primarily to supplement and test statistical estimates and would rely on them exclusively only if historical data were unavailable or too unreliable to provide a basis for forecasting (Studies in Costing, Solomons, ed.). It must, of course, be recognized that both the statistical and the engineering methods utilize historical data, frequently the same data. The engineering approach, however, is more concerned with physical unit data than with dollar costs It attempts to determine the **physical inputs** necessary to achieve certain levels of output and then converts these to dollars. Although the engineering method may apply statistical analysis to historical data, it is generally more flexible than the statistical approach. It is also more time consuming and costly than other methods. Its main characteristic is diversity, and its common objective is to provide efficiency standards for various volumes.

ACCUMULATING COST-VOLUME DATA. Historical data on the relationships of cost with volume are useful for the appraisal of past performance and review of profit achieved, for the estimation of cost variability for the future, and for the guidance of managers in making decisions in which cost and revenue differences are important. Accounting conventions and bookkeeping procedures designed for other purposes may interfere with the proper identification of those costs that vary with volume. It may be found, for example, that reported costs do not vary with volume as predicted. Sound design of the **cost recording system** can produce a more accurate picture of the effect of volume on cost.

Design of Chart of Accounts. The chart of accounts and cost distribution methods should be designed so as to reveal **cost variability patterns** clearly. The accounts for each organizational and functional group should be classified as to variability, insofar as possible. Careful analysis should reduce the number of accounts in which substantial amounts of both fixed and variable costs are mixed.

Variations in Input Prices. Changes in wage rates and materials prices cause changes in recorded operating costs from period to period. Furthermore, the method of charging production with the costs of items transferred from inventory or from preceding departments can obscure underlying cost relationships. Raw materials costs, for example, will differ, depending on whether moving average, LIFO, FIFO, or standard cost is the valuation criterion. For comparison purposes all input prices for any given accounting period should be adjusted to a common level. This can be achieved by charging production and service departments with actual input quantities of labor, materials, and services, priced at standard rates. Only in this way can the price effect be separated from the volume effect without costly analysis and adjustment of recorded data.

Internal Transfers Between Producing Departments. When internal transfers of product costs from department to department are substantial, accounting methods may obscure plant-wide patterns of cost variances. Fixed and variable costs should be inventoried separately so that the fixed costs of one department do not become the variable costs of another department that receives products from the first. This argues for a cost accounting system that approaches **direct costing**, but Cook indicates (Harvard Business Review, vol. 35) that it is possible to meet these requirements under an absorption costing system, as long as fixed and variable components of cost are inventoried separately. (For a discussion of direct costing see the section on Manufacturing Overhead and Product Cost.) This principle could be modified if internal transfers were made between two **semi-autonomous profit centers** whose performance was appraised in part

on profit achieved. As Dean points out (Harvard Business Review, vol. 33), in this case an argument can be made for market-based transfer prices.

Discretionary Variations in Timing of Cost Transfers. Another problem in identifying costs that relate to volume stems from differential timing of input consumption and cost transfers. For example, factory supplies may be treated as current costs in the period in which they are released to the factory, whether or not the supplies are actually used in this period. The clerical cost of maintaining bookkeeping records of issued but unused factory supplies is generally prohibitive with respect to the benefits to be achieved, but this means that historical cost data may provide deceptive indications of the cost-volume relationship. Adjustments are necessary to smooth these irregularities in timing.

Other costs may change either in anticipation of changes in volume or in delayed response to such changes. Design and process engineering and purchasing costs are examples of costs that may lead volume changes; warranty service and some forms of maintenance may lag. These leads and lags can be allowed for in many cases by selecting a separate index of volume for these out-of-phase costs; for example, number of purchase orders as the index of purchasing activity. In others a lagged correlation study may be satisfactory. Whenever leads or lags in substantial cost items are suspected, one of these methods should be tested.

Spurious Changes in Allocated Costs. In studying cost structures of departments, divisions, or other organizational segments of the company, the amount of cost allocated to the segment may show strong variability with volume or it may show little or no response to volume at all. In both cases the cost-volume relationship revealed in routine accounting reports may be the result of **allocation methods** in use rather than an indication of the true response of costs to volume changes.

Two situations may be distinguished. In the first, the unit's relative or absolute use of outside facilities or services can be determined; for example, a department's occupancy of floor space or consumption of electric power, in which case space rentals and power costs can be allocated on a use or occupancy basis. In the second situation, use or occupancy cannot be determined uniquely in physical terms (for example, a department's use of general factory management time), in which case allocations may assume a relationship between use or occupancy and some physical or dollar index such as the department's percentage of total factory direct labor hours.

Both situations give rise to ambiguities in the resulting cost allocations. **Occupancy costs** in the first situation, such as space rentals, are ordinarily fixed, and the allocation method affects only the level of costs and not their variability. **Use costs** such as power costs, on the other hand, vary with the department's demand for service. If the costs of electric power are allocated to consuming departments on the basis of consumption times the average actual costs of power during the month, the cost charged to any one department will depend not only on that department's consumption but also on total power consumption throughout the factory and on the efficiency at which the power plant is operated during that month. Variations in these other factors from month to month will produce recorded costs in a consuming department that do not reflect entirely the cost variance associated with the consuming department's use of power.

Allocated costs of the other major type, those for which there is no unique physical index of use or occupancy, are even more difficult to interpret. The customary allocation methods, such as average cost per direct labor hour, tend

to overstate the degree of variability that actually exists. Omitting these costs from the department's cost reports. on the other hand, tends to understate variability. It is usually necessary to study these costs in total at their source (for example, for the factory, division, or company as a whole) and attempt to separate the fixed portion from the portion that relates to departmental activity.

The variable portion of these service department and general costs should be allocated to divisions or departments using the services at a **fixed price per unit** of service consumed. The fixed portion of these indirect costs, if allocated at all, should be apportioned as fixed sums predetermined in advance. In this way cost allocations will not produce spurious variability in cost behavior.

SELECTING SCOPE OF ACTIVITY. The reliability of the indicated cost-volume functions depends to a large extent on the scope of the segment of the company's total activity to which the cost function is related. Two opposing forces are at work. First, narrower segments tend to be more **homogeneous**, so that a single index of volume can reflect more adequately the rate of activity. On the other hand, broader segments are more **self-contained**, so that fewer cost allocations and internal transfer charges are necessary to determine the full cost of the segment. The first of these affects the reliability of the variable cost component of the segment's cost function; the second influences the level of fixed costs and in some cases the variable cost function as well.

Aggregating Variable Costs. The index of volume tends to be more reliable when the operation is relatively homogeneous. Thus it is easier to select an index of volume for a division that makes and sells only one product than it is for the company as a whole, encompassing many divisions and many products. When the activities of the various parts of a segment are similar, a fairly reasonable **single-valued, variable cost function** can be developed by adding the cost and activity rates of the separate parts. The attempt to develop an **aggregate variable cost function** for a multi-product plant or for a multi-plant manufacturing division, however, is subject to greater difficulties. This point is recognized by the NAA Committee on Research in NAA Research Series No. 17 (NAA Bulletin, vol. 31), which states:

> . there are many cases where wide differences in products and methods with which they are made and sold make it impossible to combine them without destroying the significance of the resulting figures.

The customary method for developing aggregate variable cost functions for a complex organization segment is to estimate variability for each relatively homogeneous activity and then combine these on the assumption of a specified mix of products, plants, territories, or divisions. The error range in the composite function, therefore, will depend on the diversity of cost conditions in the various subsegments and on the variability of the relative mix. A shifting **regional sales pattern**, for example, could shift the proportion of total manufacturing activity represented by the various plants and make a composite manufacturing division cost function meaningless for planning purposes.

An even greater difficulty arises whenever an attempt is made to develop a single cost function encompassing both production and selling activities. NAA Research Series No. 17 (NAA Bulletin, vol. 31) states this as follows:

> Variable manufacturing costs tend to vary with production volume while variable selling costs follow sales volume, and hence the sum of these two classes of costs and also profits tend to fluctuate in an erratic manner when significantly large changes in finished goods inventory have taken place.

For the analysis of distribution methods or product line profitability, this difficulty can be surmounted by using sales value of production as the index of manufacturing activity and assuming sales and production volume to be equal so that the manufacturing and nonmanufacturing cost functions can be added together. In forecasting and budgeting, however, volume differences in different functional activities must be recognized. If sufficiently large, they may make it impossible to develop any meaningful cost-volume function for the division or company as a whole.

Interunit transfers of goods and services may also obscure cost variance patterns in narrow activity segments. Conventional accounting practice is to include in the cost of goods or services transferred between departments a charge for part of the fixed costs of the department originating the transfer. In the cost accounts of the department receiving the goods or services, the total cost of the transfer appears as a variable cost. If the two departments are merged for the purpose of deriving cost variance functions, this **spurious variability** cancels out. For the narrower segment represented by the receiving department, the level of variable costs will be overstated by the amount of fixed costs included in the cost of transferred units. This refers not only to semi-processed materials transferred from one production department to another but also to the cost of services provided production departments by service departments, such as power or maintenance.

Allocation of Fixed Costs. Many costs are common to more than one activity; for example, department, plant, division, product line, or sales territory. The fixed component of these **common costs** cannot be allocated in any meaningful way to the various segments to which they apply. This means that the fixed cost component of the cost structure of a plant, for example, is more readily determinable than for any individual department within the plant.

NAA Research Series No. 19 (NAA Bulletin, vol. 32) distinguishes between **separable costs** and **joint costs**. Separable costs are those that can be traced to specific segments of the business; joint costs, to quote the NAA study, are those "for which no fully satisfactory basis for allocation can be found." For example, in assigning manufacturing costs to individual plants, each plant manager's salary is separable or traceable to his plant, whereas the salary of the manufacturing vice-president is a joint cost. The definition of what is a separable cost and what is a joint cost depends on the segment being studied. NAA Research Series No. 19 states:

> Many costs which are direct as to major segments such as product lines or sales divisions are joint when considering subdivisions of these segments such as individual items within a product line or individual salesman. Similarly, costs which are readily separable by product lines may be joint as to sales territories, and vice versa.

This means that substantial portions of fixed costs cannot be identified with specific segments of the business and furthermore that the smaller the segments, the smaller is the proportion of total fixed costs that can be assigned to individual segments. Fortunately, in developing cost-volume functions, the problem of allocating fixed costs to segments of the business is less important than the problem of aggregating variable cost functions because managerial decisions for which knowledge of cost-volume functions is useful should ignore arbitrary allocations of fixed costs.

The main impact of the allocation of joint fixed costs is on the location of the **break-even points** for segments of the business. Assigning more fixed costs to a

particular segment has the effect of raising the indicated break-even volume for that segment. If joint fixed costs are not allocated to segments, on the other hand, then the segment break-even points will be low, and total break-even volume for the company will be greater than the sum of the break-even volumes for the various segments. Furthermore the method used to allocate the joint fixed costs to segments will determine which activities have high break-even points and which will have low break-even points.

There is no way out of this dilemma. Indirect fixed costs may be allocated to segments and thereby produce break-even points that can be aggregated under certain assumptions to produce a single break-even volume for the firm as a whole, but it is questionable whether there are any benefits that would justify taking the trouble to do this. As stated by the NAA Research Committee in NAA Research Series No. 17 (NAA Bulletin, vol. 31):

> Where a significant portion of the facilities represented by the fixed costs is shared in common by the various products, difficulties which are inherent and cannot be readily overcome cause the resulting break-even figures to have only limited reliability in many cases.

Presentation of Cost-Volume-Profit Relationships

BREAK-EVEN AND PROFIT-VOLUME CHARTS. Vance (Theory and Technique of Cost Accounting) describes a **profit graph** as ". . . a graph showing the amounts of fixed and variable costs and the sales revenue at different volumes of operation." Vance explains that the name arises from the fact that

> the difference between the total of fixed and variable costs and the sales revenue at any volume gives the profit at that volume. Because of the importance of the point at which the total costs and the revenue are equal the graph is often called a "break-even chart"—it shows at what volume the firm just covers all costs with revenue, or "breaks even."

Thus, a profit graph is a condensed pictorial representation of a master flexible budget, showing the normal profit for any given sales volume. It is a useful device for presenting a simplified picture of profit-volume relationships and to aid in demonstrating the effects of changes in various factors such as volume, prices, and costs.

Break-even Chart. One form of profit graph is the break-even chart, illustrated in Fig. 3. This is drawn as follows:

1. Select a **summary index of volume.** A physical index of output (units of product) is preferable because it is not influenced by changes in selling prices, but when many products are included, a dollar index may have to be chosen. The index most commonly used is sales dollars, but it is preferable to use standard sales dollars for reasons that are discussed in paragraph (3) here. This index may be converted into percentage of some stated capacity, for ease of presentation.
2. Draw **co-ordinates** for a chart on a sheet of graph paper. Distances to the right of the left-hand axis represent volume, and distances above the horizontal base line represent costs and revenues.
3. Plot **sales dollars** on the chart. The typical break-even chart plots sales revenue as a straight line starting from the lower left-hand corner of the chart and rising to the right (Fig. 3). If actual sales dollars are selected as the index of volume, the sales line will appear as a straight line at a 45 degree angle to the base, provided the scales on the horizontal and vertical axes are the same.

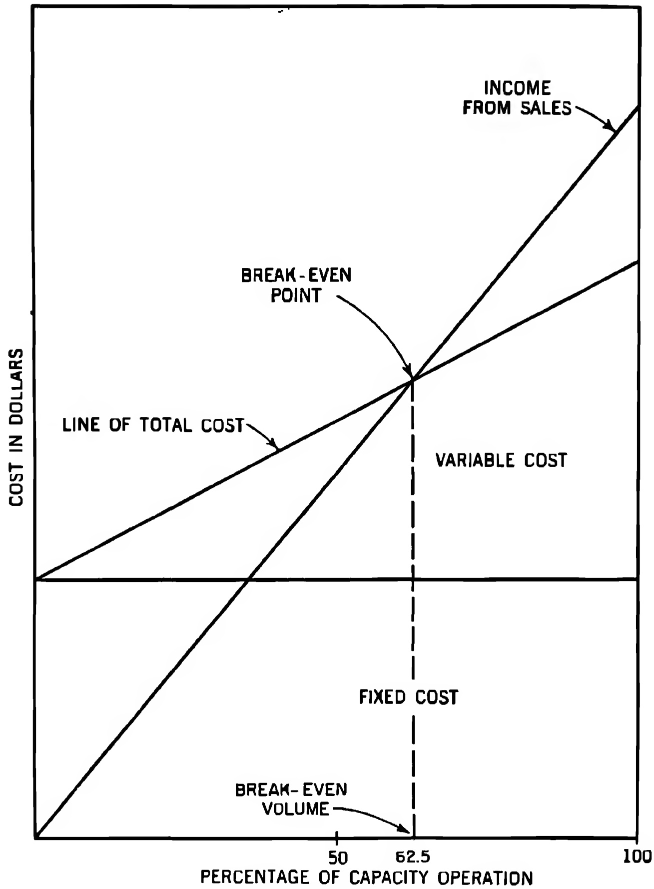


Fig. 3. Break-even chart.

This means that the cost line will have to be changed to illustrate the effects of any changes in sales prices. This can be avoided by embodying a schedule of fixed prices in the sales dollar index of volume; i.e., the index of volume will be stated in terms of standard sales dollars. Any deviation of actual or proposed selling prices from standard selling prices can then be portrayed by shifting the sales line rather than the cost line.

4. Plot a **total cost** line to represent at each volume the total of all items of cost.
5. The **spread** between the total cost and the total sales lines at any volume indicates the **expected profit or loss** at that volume. The volume at which the two lines cross is known as the **break-even volume** and the point of intersection is known as the **break-even point.**

Heckert and Willson (Controllership) present a more detailed version of the break-even chart (Fig. 4). This chart points out the volume level at which normal dividend requirements will be met, the level and distribution of expected profits, and a detailed cost breakdown, as well as the usual break-even point.

Another presentation along somewhat similar lines would be to eliminate most of the cost breakdown, perhaps distinguishing specifically only **depreciation** and any other **noncash costs** so that the cash generated by current operations could also be visualized.

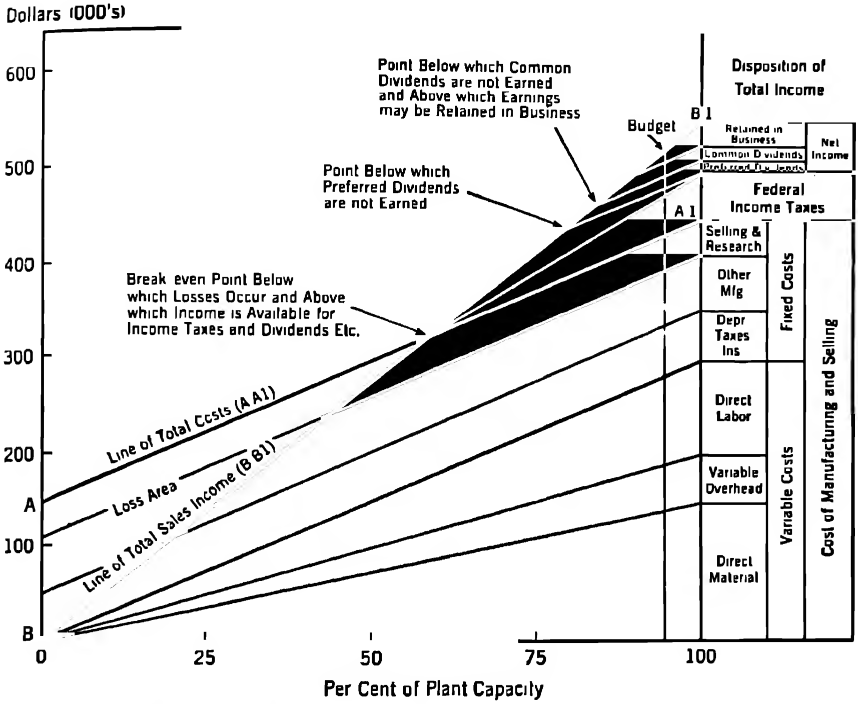


Fig. 4. Detailed break-even chart, relating sales income and its disposition.

Various other forms of the break-even chart may be used to bring out the significance of the factors involved. The use of shaded areas is illustrated in Fig 5 from Heiser (Budgeting—Principles and Practice). Brenneck (NAA Bulletin, vol 40) suggests the use of logarithmic scales in break-even analysis in cases where the learning curve reduces the variable cost per unit.

Profit-Volume Chart. Another diagram for presenting similar data is the profit-volume chart (Fig. 6), sometimes called the "profit-volume analysis graph." In this diagram the horizontal axis again represents total volume. Distances above or below this line represent profits or losses. This may be regarded as the break-even chart tilted sideways and inverted so that the base line is the sales line in the break-even chart. The points of this profit line are computed by subtracting from sales income the total cost indicated for each volume. The break-even point is indicated by the intersection of this profit line with the horizontal axis. Actual sales dollars may be used as the index of volume in this chart.

In constructing either a break-even chart or a profit-volume chart, **inventory changes** are ignored; sales and production volumes are assumed to be identical.

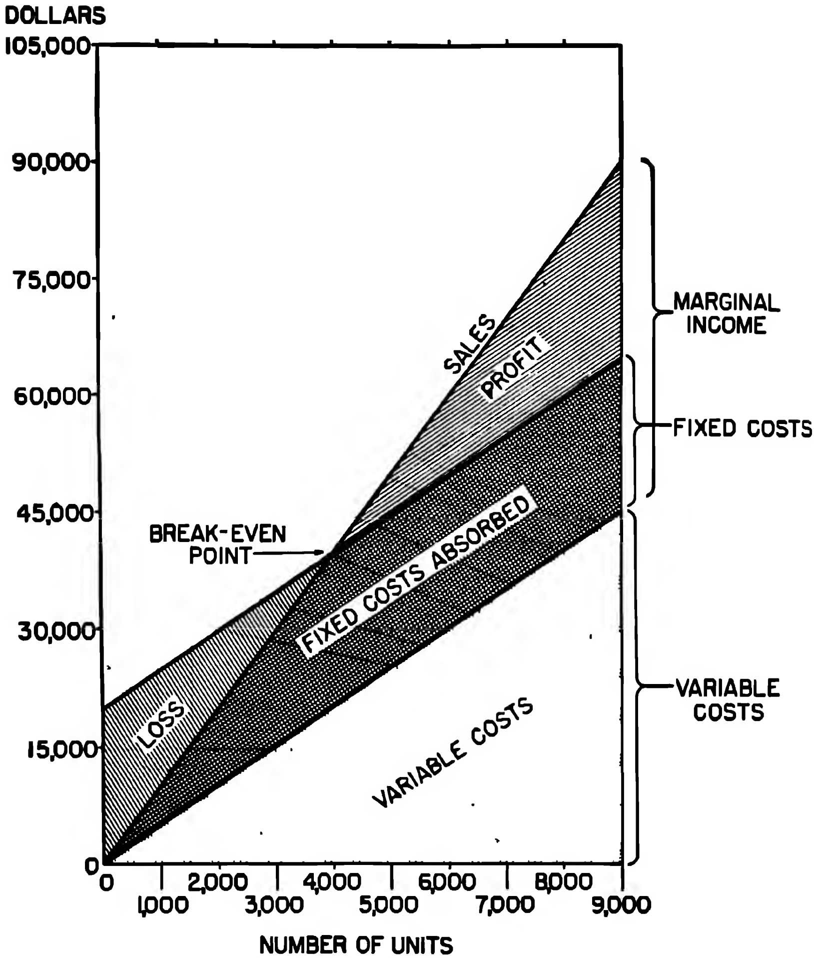


Fig. 5. Volume-cost-profit relationship. (Break-even chart.)

RATIOS AND BREAK-EVEN POINTS. Information plotted on the profit graphs may be summarized in mathematical terms. The break-even chart, for example, is simply a graph of two straight lines. The equation for the **sales income** may be expressed as $S = aV$, where S stands for dollar sales, V stands for the index of volume, and a represents the slope of the line which equals the sales dollars per unit of volume. The equation for the **variable cost** line is $C = bV$, where C is total variable cost and b is the slope of the line or the variable cost per unit of volume. **Fixed cost** is represented by a straight line parallel to the horizontal axis, cutting the vertical axis at d which is the amount of total fixed cost. The equation for **total cost** T, therefore is $T = d + bV$. These equations can be used to derive certain ratios and the break-even point.

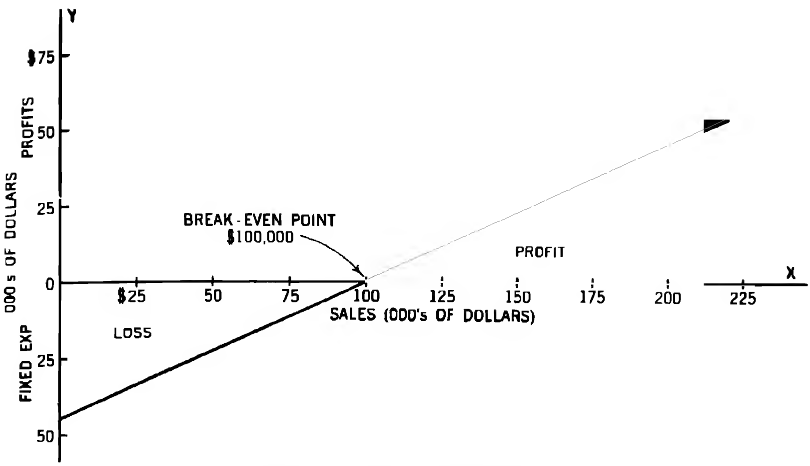


Fig. 6. Profit-volume chart.

Break-even Point. The volume of activity at which total sales income just equals total variable and fixed costs is known as the **zero-profit volume** or **break-even point**. The sales and cost equations can be solved simultaneously to produce a formula for the break-even point, as follows:

Sales equation: $S = aV$

Cost equation: $T = d + bV$

The business breaks even when $S = T$. Substituting S for T, the second equation becomes

$$S = d + bV$$

$$aV = d + bV$$

$$V = \frac{d}{a - b}$$

or

$$\text{Break-even volume} = \frac{\text{total fixed cost}}{\dfrac{\text{total sales} - \text{total variable cost}}{\text{units of volume}}}$$

If volume is measured in sales dollars, this equation becomes

$$\text{Break-even volume} = \frac{\text{total fixed cost}}{1 - \left(\dfrac{\text{total variable cost}}{\text{total sales}}\right)}$$

For example, if fixed costs total $45,000 and the percentage of variable costs to sales is 55 percent, the break-even volume in dollars is

$$X = \frac{\$45{,}000}{1 - 0.55} = \$100{,}000$$

This may be converted into a **percentage of capacity** figure if desired. If r represents the ratio of the break-even point to capacity, and it is assumed that the capacity in the preceding example is $200,000 of sales per period, the equation becomes

$$r = \frac{\text{total fixed cost}}{\left[1 - \left(\frac{\text{total variable cost}}{\text{total sales}}\right)\right] \text{capacity}}$$

$$= \frac{\$45{,}000}{(1 - 0.55)(\$200{,}000)}$$

$$= 50\%$$

The previous equation shown for the break-even point in sales dollars is widely used in the literature of accounting.

Keller (Management Accounting for Profit Control) shows the following formula to express the break-even point in units:

$$\frac{\text{Fixed expense dollars}}{\text{Unit sales price} - \text{unit variable cost}}$$

If it is assumed in the preceding example that the number of units at capacity is 50,000 per period, then the unit sales price would be $4.00 (i.e., $200,000/50,000), and the unit variable cost would be $2.20 (i.e., 55 percent of $4.00). The computation then becomes:

$$\frac{\$45{,}000}{\$4.00 - \$2.20} = 25{,}000 \text{ units}$$

Other Uses of Break-even Formulas. With a slight adjustment, the break-even formulas may be used to determine other volume levels besides the break-even point itself. For example, if it were desired to know at what level the firm in the foregoing example would have to operate to earn **net income** equal to 10 percent of net sales, this 10 percent would be treated as an addition to the variable cost. The desired sales volume would be equal to

$$\frac{\$45{,}000}{1 - (0.55 + 0.10)} = \$128{,}571.43$$

If it were desired to know at what level the same firm would have to operate to earn a stated amount of dollars of **net profit,** say, $10,000, this figure would be added to the fixed cost. The desired sales volume would be equal to

$$\frac{\$55{,}000}{1 - 0.55} = \$122{,}222.22$$

Break-even Analysis, Budgets, and Standard Costs. The raw materials for break-even charts generally come from flexible budgets and standard costs. Matz–Curry–Frank (Cost Accounting) state that, "the information needed for the break-even analysis and charts is but a by-product of the current flexible budget." **Standard costs** of labor and materials, embodying expected prices and operating methods, provide the basis for predicting the behavior of these costs in response to shifts in volume. Matz–Curry–Frank go on to say that the flexible budget

amounts to a summary of standards expressed in the familiar tabular form . . . whose data . . . can be used directly and without refinement for break-even analysis or converted into a break-even chart, which is more likely to be read and understood than is a budget in tabular form.

Limitations of Break-even Point. The break-even point itself is of limited significance. It provides neither a standard of performance nor a guide for executive decisions. No business is conducted in order to break even. The proximity of the break-even point may influence management's attitudes toward costs and risks or toward the urgency of cost reduction efforts. The urge to avoid reporting a loss will very likely lead to a downward shift in break-even points through reductions in fixed costs when business is poor. But this does not give a broad base for decision making, and management does not expect it to do so.

Furthermore, because of the many restrictive assumptions that must be made in order to compute a break-even chart, the break-even point is only an approximation at best. As Keller says (Management Accounting for Profit Control), "The relationships will be true only within a limited range of activity above and below the level for which the data were computed. Also, they will be applicable only for the average prices, product mixture, and costs which were used in developing the data for plotting the chart." The word "point" carries the connotation of great exactness. A better term would be **break-even area,** to indicate that the precise location of the break-even volume is not known and can be estimated only roughly. To dramatize this point, the cost and revenue lines should perhaps be drawn on the chart as wide bands, with intersection over a wide area.

Patrick (Accounting Review, vol. 33) lists the following assumptions which underlie the conventional break-even analysis for a manufacturing situation:

1. Costs are either fixed or variable, or at least they can be so classified for purposes of this analysis.
2. Fixed and variable costs are clearly separated.
3. Selling price is constant regardless of the level of output
4. There is one product, or a constant sales mix if more than one product
5. Production and sales are equal, and as a result, all fixed costs incurred in the period covered by the analysis will be deducted from revenue realized in the same period.

There is the further assumption, in connection with (1) and (2), that the fixed and variable costs remain unchanged during the period of analysis. Patrick points out that assumption (5) often does not hold, and in these cases some of the fixed costs can be deferred in inventory, some can be included in the cost of sales, and the portion attributable to idleness can be charged off as a period loss. He demonstrates that there are many combinations of sales and production which result in no profit or loss, and that instead of there being a single break-even point, there is a **break-even line.**

These limitations do not mean that break-even analysis is useless. Keller concludes that break-even studies "provide valuable information for the guidance of management if they present the assumptions on which they are made and state the limits of their applicability." The greatest value in break-even analysis comes not from the location of the break-even point but from the underlying relationships revealed among volume, costs, and profit.

A mail questionnaire to 344 companies by the Controllership Foundation (Business Budgeting, Sord and Welsch) showed that 51% used break-even analysis in some way.

Profit-Volume Ratio. One way of expressing the relationships among costs, revenues, and volumes is the profit-volume ratio. This ratio (P/V) is the rate at which profit increases with increases in volume, and is given by the formula:

$$\frac{P}{V} = 1 - \frac{\text{variable costs}}{\text{sales}}$$

or

$$\frac{P}{V} = \frac{\text{sales} - \text{variable costs}}{\text{sales}}$$

This may also be expressed as

$$\frac{P}{V} = \frac{\text{fixed cost} + \text{profit}}{\text{sales}}$$

This is equal to the slope of the profit line in the **profit-volume chart** (Fig. 6) and can be computed directly from the chart:

	Sales	Total Costs	Net Profit
	$220,000	$166,000	$54,000
	200,000	155,000	45,000
Change	$ 20,000	$ 11,000	$ 9,000

$$\frac{\text{Profit change}}{\text{Volume change}}\ \frac{P}{V} = \frac{\$\ 9{,}000}{\$20{,}000} = 45\%$$

Multiplying the monthly sales by 55 percent yields the variable costs. Variable costs subtracted from total costs yield fixed costs.

The P/V ratio is sometimes called the **marginal income ratio,** or **variable profit ratio.** Lang–McFarland–Schiff (Cost Accounting) warn that:

> The marginal income ratio should not be confused with the percentage which net profit bears to sales. The latter ratio changes as volume varies and has a quite different interpretation.

Like the variable cost ratio, the marginal income ratio for any given product is assumed to be constant over substantial ranges of volume. According to Lang–McFarland–Schiff, this "makes it possible to determine what change in profit will result from a given change in volume, provided other conditions remain the same." It is most useful in some kinds of **product analysis** in which it is desired to compare profit margins on different products or combinations of products without studying product costs and prices separately. Lang–McFarland–Schiff also point out that the size of the P/V ratio is an index of the responsiveness of net profit to changes in volume. A high P/V ratio may indicate that substantial sales promotion effort per dollar of added sales will be profitable, but NAA Research Series No. 17 (NAA Bulletin, vol. 31) appends a warning that "additional expenditures for sales promotion may bring similar intensification of competitors' selling efforts which partly or wholly cancel the advantage gained."

Margin of Safety. Sales in excess of the break-even volume represent a margin of safety (M/S). This excess may be expressed as a percentage of sales:

$$\frac{M}{S} = \frac{\text{actual sales} - \text{sales at break-even point}}{\text{actual sales}}$$

Since break-even sales volume depends on the level of fixed costs and on the P/V ratio, margin of safety will change with changes in sales volume, P/V ratio, and

fixed costs. If the *P/V* ratio and sales volume are stable, it may be possible to increase the margin of safety by reducing fixed charges. If the *P/V* ratio and total fixed costs are constant, then increases in sales volume will increase the margin of safety.

Both the break-even point and the margin of safety ratio are static rather than dynamic concepts. Shifts in volume, particularly downward shifts, are likely to be accompanied by changes in either the *P/V* ratio or the amount of fixed costs, or both. Such changes affect the location of the break-even point and the size of the safety margin. According to Keller (Management Accounting for Profit Control):

> The margin of safety is a theoretical ratio not likely to hold if conditions occur which cause it to be invaded. However, a substantial margin of safety does indicate that a company or a unit of a company is less vulnerable to a decline in sales than one which has a very narrow margin of safety.

Marginal Income. The contribution of a given segment of sales to cover fixed costs and provide a profit is variously called **marginal income, variable profit,** or **marginal balance.** It is obtained by subtracting from sales revenue for a particular segment of the business the variable costs that relate to that revenue. If selling prices, product mix, and product *P/V* ratios are assumed constant, it can be calculated by multiplying total sales for the segment by the *P/V* ratio for that segment.

To illustrate, fixed costs total $45,000 and total sales of $200,000 are derived from the sale of three products, as follows:

Product	Sales (000's)	*P/V* Ratio	Marginal Balance (000's)
A	$ 50	.60	$ 30
B	125	.40	50
C	25	.40	10
Total	$200	.45	$ 90
Fixed Costs			45
Profit Before Taxes.....			$ 45

The total marginal balance of these three products is $90,000, $45,000 of which goes to cover fixed costs and the remaining $45,000 of which is accounted as profit before taxes.

Marginal balance should not be confused with **contribution margin,** which represents the contribution of a particular segment to fixed costs and profit of a larger group of activities of which this segment is a part. In the illustration given, Product A's contribution to the division's total profit may be less than its $30,000 marginal balance if some of the fixed costs can definitely be identified as resulting from the existence of Product A in the line. In computing contribution margin, these traceable fixed costs must be subtracted from marginal balance or variable profit.

The marginal balance is usually projected to vary directly with the physical volume of sales. NAA Research Series No. 17 (NAA Bulletin, vol. 31) warns, however, that, "if the additional goods sold or projected to be sold have different costs or selling prices, it will be necessary to calculate the marginal balance on the new business according to the facts of the situation." In any analysis the use of constant ratios should be questioned to determine whether this assumption fits the facts.

Many authorities have argued the superiority of contribution-type income statements for internal purposes. Heiser, for example (NAA Bulletin, vol. 34), presents the following report form (dollars in thousands):

	Plant Total	Department 1 Dept. Total	Product A	Product B	Product C	Department 2 Dept. Total	Product D	Product E
Sales	$3,340	$915	$375	$290	$250	$2,425	$1,625	$800
Variable CGS	1,895	520	225	145	150	1,375	975	400
(Percent of sales)	57%	57%	60%	50%	60%	56%	60%	50%
Dept. mfg. margin	$1,445	$395	$150	$145	$100	$1,050	$ 650	$400
Dept. fixed costs	600	400				200		
Plant mfg. margin	$ 845	($5) Loss				$ 850		
Plant fixed costs:								
Manufacturing	300							
Sell. and admin.	400							
Operating profit	$ 145							

Any **separable fixed costs** traceable to specific product lines should be deducted in computing product contribution margin. In the illustration given, it was assumed that none of the fixed costs could be traced in this way. NAA Research Series No. 17 (NAA Bulletin, vol. 31) cites as the main advantage of this type of report that it permits management to see directly the effect on company profit of specific changes in sales or costs. It contrasts this form of report with the more conventional income statement, which "requires much analysis to interpret and the reasons for many changes cannot be readily determined from the statement or from comparative statements by themselves."

PROFIT PATH. Conway (NAA Bulletin, vol. 38) states that "the characteristic which has limited the use of break-even analysis more than any other is undoubtedly the relative inability to treat multiple-product firms or situations." One device that has been developed to cope with this problem is what Matz–

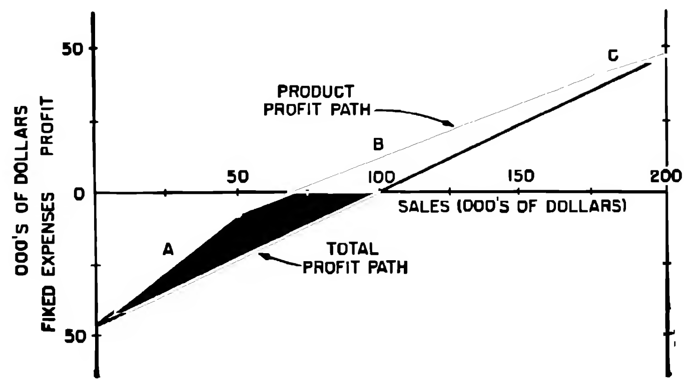


Fig. 7. Profit path chart.

Curry–Frank (Cost Accounting) call the **profit path chart** (Fig. 7). This chart is constructed by dividing total sales into segments, one for each product, product group, territory, division, etc.

The **total profit path** is the profit line from the profit-volume chart (Fig. 6) extended to actual sales volume of $200,000. The **product profit path** is plotted, starting with the product with the highest *P/V* ratio (Product A). The line begins at the total fixed cost point ($45,000) on the left-hand axis and rises to $15,000 in the loss area at the $50,000 sales volume point. This indicates that $30,000 of the $45,000 fixed costs have been recovered by Product A. The profit path of Product B starts at this point and rises to $35,000 in the profit area at $175,000 sales volume. The path for Product C starts at this point and ends at $45,000 net profits.

Use of Nomographs. May (NAA Bulletin, vol. 37) suggests an alternative procedure whereby separate profit paths for each product are superimposed on each other in the form of a nomograph instead of being linked together in the form of a kinked chain, as in Fig. 7. Conway (NAA Bulletin, vol. 38) finds that the usefulness of this nomograph, or "profit polygraph," approach is limited by its greater complexity.

In either form the product profit path permits visualization of the relative profit contribution of each of the company's products (or territories, divisions, customer classes, etc.). It does not, of course, reveal the over-all profitability of each product because product contribution must consider the existence of separable fixed costs. Furthermore, as Conway points out, "The point at which the segmented profit function indicates a zero profit does not qualify as a break-even point, because this point obviously depends upon the order in which the products are plotted." Its main usefulness lies in its ability to dramatize relationships among the profit-volume ratios of the various products.

Use of Computers. The introduction of **electronic computing equipment** capable of handling equations in many variables may permit a fundamentally different approach to cost variance analysis. Manual computation methods become extremely laborious as the number of variables is increased to more than four or as **nonlinear relationships** are introduced. Conway (NAA Bulletin, vol. 38) concludes that the use of electronic equipment will permit a breakaway from the restrictive assumptions governing the typical break-even charts illustrated here. Nonlinear cost and revenue functions, time delays, interdependencies among products, and other complex relationships can be introduced to obtain a more sensitive picture of cost-volume-profit patterns. Techniques for **simulation** of the outcome of various decisions are now being applied in other areas with the aid of computers, and these techniques may be similarly applied to cost-volume-profit analysis.

Capital Graph Chart. An interesting extension of the profit graph approach is presented by Gardner (Profit Management and Control). He distinguishes between fixed and variable capital. **Fixed capital,** or "float," is defined as the amount of capital required irrespective of sales volume, whereas **variable capital** represents the portion of total capital requirements that varies with volume. This kind of analysis is most useful in estimating the variable capital requirements associated with a change in sales volume and in examining the "efficiency" with which capital is presently employed. It facilitates before-the-fact planning and after-the-fact remedial action if idle capital exists. Gardner also

indicates how the **variable capital ratio** can be used in the study of growth financing. Gardner uses the following example:

Added capital required for $100 added sales	$19.36
Variable profit from $100 added sales	$22.65
Less income tax at 50%	11.33
Variable profit after tax	$11.32
Less dividend requirements at 50%	5.66
Retained earnings per $100 added sales	$ 5 66

From these calculations he derives an **annual growth factor,** the amount of sales increase in the following year that can be financed by each $100 of sales beyond the break-even point this year. In this example, if $19.36 added capital is required to finance $100 of added sales, then the $5.66 of retained earnings generated this year is adequate to finance $5.66/$19.36 of $100, or $29.24, of added sales next year. The assumption of constant percentage of dividend requirements may be questioned (and this analysis is subject to the limitations of the underlying ratios themselves), but it provides an additional application of the fixed-variable principle.

Both Gardner (Profit Management and Control) and Spencer (NAA Bulletin, vol. 38) combine profit and capital functions in composite charts. Fig. 8 is

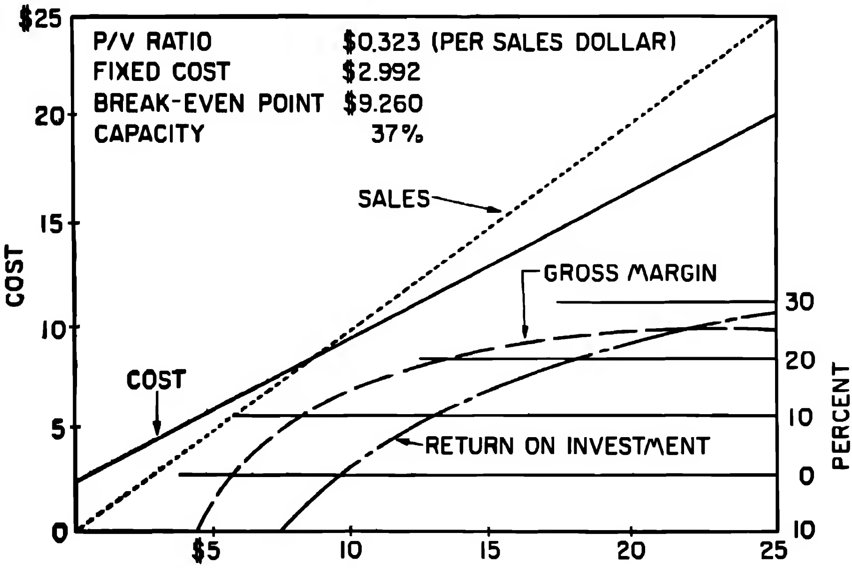


Fig. 8. Profit graph ($ in millions).

adapted from Spencer's chart, which he labels a **profit graph.** It permits visualization of percentage return on investment as well as the total volume function.

USEFULNESS OF PROFIT GRAPHS. Each of the six types of profit graphs illustrated (Figs. 3, 4, 5, 6, 7 and 8) is useful primarily as a pictorial

device to assist in the presentation of cost-volume-profit relationships to interested executives. Their usefulness as analytical devices is limited by the restrictive nature of the assumptions necessary to their construction (which have been pointed out), as well as by the fact that in most cases it is necessary to perform the underlying analyses in numerical form before the charts can be drawn.

Effect of Price Changes. The profit graph is frequently used to illustrate the potential profit effects of contemplated price changes. An increase in average selling price lowers the break-even volume and increases the *P/V* ratio. This means that if physical sales volume is not reduced by the increase, dollar sales volume will increase and net profits will increase even more. In Fig. 9, for example, a 12½ percent increase in price would increase profit by $50,000, or more than 100 percent, if unit volume remained constant. If volume were reduced from 200,000 units to 160,000 units, however, the net effect of the price change would be to increase profit by $20,000, from $40,000 to $60,000, even though total dollar sales would be decreased by the price change.

Shifts in Product Mix. The profit-volume chart may also be used to illustrate the effects of shifts in product mix. Separate profit lines can be drawn for each of several assumed profit mixes (Fig. 10). The steeper profit line in this chart represents a richer mix of the products with high profit-volume ratios.

In considering a possible shift in product mix, it must be recognized that changes in mix do not result automatically from a decision to change except under relatively rare circumstances. Existing product mixes are the result of a combination of circumstances, including prices, competitive conditions, demand for the products by potential customers, and so on. Effort is required to disturb this balance, and this process is seldom costless. It may be necessary to increase fixed distribution costs or to adjust the relative price structure of the product line, which in turn will change the relative profit-volume ratios. The apparent increase in profit shown by the chart must be compared with the increase in fixed distribution costs necessary to achieve this increase. If price adjustments are necessary, the chart must be redrawn to conform to the revised facts.

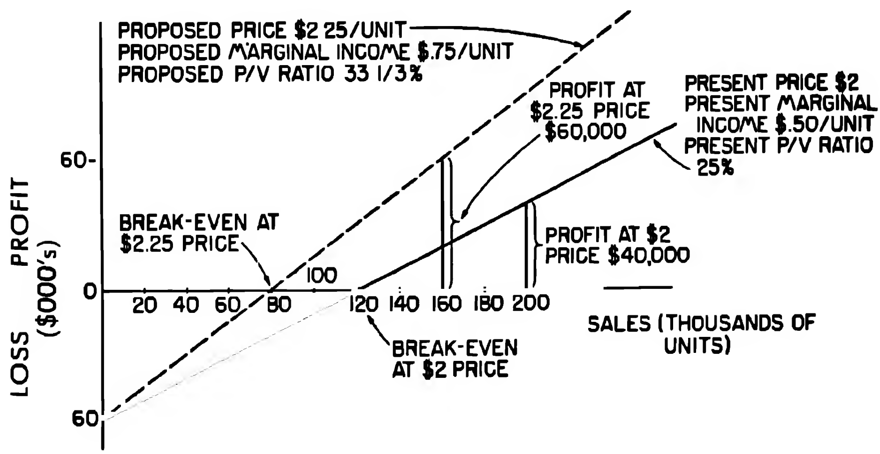


Fig. 9. Effect of price change on profit-volume ratio.

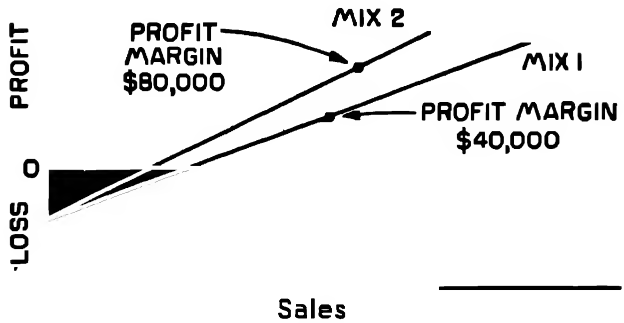


Fig. 10. Effect of shifts in product mix on product value line.

Profit Review. The various profit charts can also be used as a rough presentation device to illustrate deviations of actual performance from planned performance. A **planned profit line** can be compared with plotted points representing actual profit experience. The limitations of this technique stem from the fact that charted deviations from plan do not indicate the sources or causes of the deviations. The underlying analysis of deviations from plan must be made from the data themselves and not from the chart. The importance of budgets and standard costs in this connection should not be underestimated. Keller (Management Accounting for Profit Control) observes that "The management's knowledge of the business would be the only basis for isolating the problem in the absence of adequate costs and budgets." In the complex situations under which most large business operates, managerial familiarity with the circumstances affecting business performance is necessarily restricted; the application of business judgment requires the preparation of analytical summaries as to current conditions and trends.

Change in Sales Volume. The profit-volume chart may also be used to forecast the costs and profits that are likely to result from changes in sales volume. Once again, however the profit graphs should not be applied without modification because the spread between the cost and sales lines on the break-even chart may not give an accurate picture of the dynamic effects of shifting to a new volume. For example, in the case of an increase in sales volume, some of the distorting factors may be:

1. Increases in fixed costs.
2. Decreases in sales price or increased discounts and allowances at higher sales volumes.
3. Increases in variable manufacturing costs due to such factors as bottlenecks, shift differentials, overtime premiums, and use of untrained personnel.
4. Increases in sales force with less than proportionate increases in sales.
5. Increased capital requirements. The typical profit chart does not include a charge for invested capital, and increased sales volume may require additional working capital and possibly even increases in plant and equipment. Return on money employed must be considered in evaluating a policy of expanded sales.

Probably the most satisfactory device is the use of the chart to show the increase in profit contribution that would result from a change in volume or price,

or both, and then the comparison of this in a separate chart with the increase in fixed selling and/or manufacturing costs necessary to achieve the added sales. In this form the chart can be quite useful.

ANALYZING PROFIT VARIATIONS. For continued success, business must plan for its profits in advance. It must also match current performance against the plan in order to adjust the plan quickly to changing conditions and to find out where control has been inadequate. For example, a monthly **profit performance summary** could contain the information shown in Table A. In this table and in those that follow (B–J), all deviations from the planned figures, which tend to decrease profits, are shown in parentheses. All dollar figures are expressed in thousands of dollars.

TABLE A PROFIT PERFORMANCE SUMMARY
(Dollars in thousands)

	Budget	Actual	Deviation
Sales	$2,000	$2,160	$160
Less: Standard cost of goods sold	1,400	1,614	(214)
Variances from standards	—	(19)	(19)
Add: Overabsorbed fixed manufacturing cost	—	20	20
Gross Margin	$ 600	$ 547	($ 53)
Less: Nonmanufacturing expense	350	366	(16)
Net profit before taxes	$ 250	$ 181	($ 69)

In order to provide useful information for planning and control, these deviations from planned profit should be analyzed to determine the **underlying causes** in terms of the effects produced by deviations in each of the major determinants of profit, such as deviations from planned:

1. Selling prices.
2. Sales volume.
3. Product sales mix.
4. Fixed cost absorption.
5. Manufacturing costs.
6. Nonmanufacturing expenses.

A separate analysis should be made for each major segment of the profit plan, such as each product line. This **segment analysis** is most important when the company is decentralized into a number of semi-autonomous profit-responsible units, but it should be undertaken in any case whenever profit behavior varies significantly among product lines, regions, or other segments of the company's operations.

Components of Profit Variances. The actual categories used should be adapted to fit the company's specific circumstances, but the subsequent paragraphs should serve to illustrate the concepts and techniques that can be used to break the total profit variable down into its component parts. The example used has been simplified to permit a full explanation in a limited space. In tracing through this illustration, it will be helpful to refer to the basic data given in Table B. Note that the "Total" column in Table B checks with the "Budget" column of Table A.

TABLE B. SUMMARY PLANNING BUDGET
(Dollars in thousands)

	Product Line A	Product Line B	Product Line C	Total
Planned sales at standard prices	$1,000	$600	$400	$2,000
Standard cost of sales				
Materials	$ 90	$250	$ 10	$ 350
Labor	360	120	120	600
Variable burden	150	50	50	250
Total variable	$ 600	$420	$180	$1,200
Fixed burden	120	40	40	200
Total cost of sales	$ 720	$460	$220	$1,400
Planned gross margin	$ 280	$140	$180	$ 600

Fixed manufacturing burden is absorbed at a rate of 33⅓ percent of standard direct labor dollars; **variable manufacturing burden** is absorbed at a rate of 41⅔ percent of standard direct labor dollars. All manufacturing variances are closed out to cost of goods sold. All finished goods inventories are valued at standard cost and there is no work in process inventory. The $20,000 overabsorption of fixed manufacturing cost (Table A) is obtained by deducting the $200,000 of fixed burden budgeted in Table B from the $220,000 fixed burden in standard cost of goods manufactured (Table C).

Variable nonmanufacturing expenses are budgeted at 5 percent of standard sales dollars, and fixed nonmanufacturing expenses are budgeted at $250,000 per month. The **standard manufacturing cost** of goods manufactured and sold during the month is shown in Table C.

TABLE C. STANDARD COST OF GOODS MANUFACTURED AND SOLD
(Dollars in thousands)

	Product Line A	Product Line B	Product Line C	Total
Standard cost of goods manufactured				
Materials	$ 99	$350	$ 8	$ 457
Labor	396	168	96	660
Variable burden	165	70	40	275
Fixed burden	132	56	32	220
Total	$792	$644	$176	$1,612
Standard cost of goods sold				
Materials	$ 99	$375	$ 6	$ 480
Labor	396	180	72	648
Variable burden	165	75	30	270
Fixed burden	132	60	24	216
Total	$792	$690	$132	$1,614

Deviations in Selling Prices. These show the extent to which profits have varied from estimates because of variations from the selling prices on which the profit plan was based. **Selling price variance** is computed by subtracting actual sales revenues from planned sales revenues for the actual product sales mix. For example, the company may show the selling price performance, illustrated by Table D.

TABLE D. SELLING PRICE DEVIATION
(Dollars in thousands)

	Product Line A	Product Line B	Product Line C	Total
Sales, actual prices	$1,040	$920	$200	$2,160
Sales, planned prices	1,100	900	240	2,240
Selling price deviation	($ 60)	$ 20	($ 40)	($ 80)

Table D shows that there is a net unfavorable selling price deviation of $80,000. Responsibility for selling price variances normally rests with sales management, and these variances should be classified by branch territory or by class of customer. Further breakdown by individual salesmen may disclose that some salesmen sell more in dollars than others but produce a smaller profit contribution to the company because they achieve volume at the expense of greater price reductions.

Deviations in Sales Volume and Sales Mix. Differences between budgeted and actual sales volume for each product line cause profit to deviate from plan by the amount of the increase or decrease in sales at planned selling prices, minus the corresponding change in volume-related or **variable costs,** at standard. For any one product line, this difference in **variable profit** represents the effect of volume changes in that line. Where all products do not have the same marginal income, the total of the volume variances in all product lines combined reflects not only volume changes but also changes in the relative proportions in which the individual product lines were sold. The effect of changing proportions, or **product sales mix,** can be isolated by subtracting from the total variable profit contribution of all product lines the planned variable profit on actual total sales at planned prices and planned sales mix.

To illustrate, the company's profit plan and actual results, at standard costs and prices, may be those shown in Table E.

TABLE E. VARIABLE PROFIT DEVIATION
(Dollars in thousands)

	Product Line A	Product Line B	Product Line C	Total
Planned:				
1. Sales, planned or standard prices	$1,000	$600	$400	$2,000
2. Variable costs, standard				
a. Manufacturing costs	$ 600	$420	$180	$1,200
b. Nonmanufacturing costs	50	30	20	100
3. Variable profit	$ 350	$150	$200	$ 700
4. Variable profit, percentage of sales	35%	25%	50%	35%
Actual:				
5. Sales, planned or standard prices	$1,100	$900	$240	$2,240
6. Variable profit, standard (4) × (5) for product lines A, B, and C	385	225	120	730
Variable profit deviation (6) − (3)	$ 35	$ 75	($ 80)	$ 30

Table E shows that increased sales volume in Lines A and B increased company profit by $110,000 but that decreased sales volume in Line C reduced profit by $80,000. The combined effect of aggregate volume and relative mix was to

increase company profit by $30.000. Table F shows how these two components can be separated for the company as a whole.

Table F. Product Mix and Volume Deviations in Variable Profit
(Dollars in thousands)

	Variable Profit Percent of Sales	Variable Profit Total	
Planned mix, planned sales	35.0	$700	
Planned mix, actual sales	35.0	784	
Favorable effect of greater volume			$84
Planned mix, actual sales	35.0	$784	
Actual mix, actual sales	32.6	730	
Unfavorable effect of poorer product mix			($54)

In other words, if the increase in volume had been achieved by maintaining planned **product line proportions,** the increase in volume would have increased profit by $84,000, but because it was achieved by increases in low margin lines and a decrease in the high margin line, the actual effect of increased volume was only a profit increase of $30,000. These deviations should be distributed to the responsible segments of the sales organization, such as branch territories and possibly also to individual salesmen.

Deviations in Fixed Cost Absorption. Volume also has another effect if absorption costing is used for income determination. This stems partly from the fact that the greater the **sales volume,** the greater the charge of fixed costs against income. Furthermore, deviations of **production volume** from the volumes used for the calculation of burden rates produce under- or overabsorbed fixed burden, which may be charged against income, as shown in Table G.

Table G. Deviations in Fixed Cost Absorption
(Dollars in thousands)

	Product Line A	Product Line B	Product Line C	Total
Planned absorption in sales (Table B)	$120	$40	$40	$200
Actual absorption in sales (Table C)	132	60	24	216
Absorption deviation from sales volume	($ 12)	($20)	$16	($ 16)
Planned absorption in production (Table B)	$120	$40	$40	$200
Actual absorption in production (Table C)	132	56	32	220
Absorption deviation from production	$ 12	$16	($ 8)	$ 20
Absorption deviation, net	—	($ 4)	$ 8	$ 4

In this case the $16,000 deviation in fixed cost charged to cost of goods sold is more than offset by $20,000 overabsorption of current manufacturing costs in current production, showing a net favorable effect on reported profits of $4,000

If fixed costs can be traced directly to individual product lines, then this variance should be reported by lines, as illustrated in Table G. This is normally the case when separate production facilities are used for each product line. When the fixed costs are also **common costs,** not traceable to product lines, this variance should be reported only in total because the allocation of the total fixed manufacturing cost budget to product lines is essentially arbitrary.

Deviations in Manufacturing Costs. Manufacturing costs vary from planned costs for the actual volume because of a number of nonvolume factors given in the section on Accumulation of Manufacturing Overhead. These variances are reflected both in variable costs and in fixed costs in Table H.

TABLE H. DEVIATIONS IN MANUFACTURING PERFORMANCE
(Dollars in thousands)

	Budget or Standard	Actual	Price Deviations	Quantity Deviations	Net Deviations
Standard variable manufacturing costs					
Direct materials	$ 457	$ 503	$18	($64)	($46)
Direct labor	660	645	(24)	39	15
Variable burden	275	273	(6)	8	2
Total variable	$1,392	$1,421	($12)	($17)	($29)
Budgeted fixed manufacturing costs	200	190	(1)	(11)	10
Total	$1,592	$1,611	($13)	($ 6)	($19)

Standard variable manufacturing costs for the actual volume of production are obtained from Table C. Added to these is the amount of budgeted fixed manufacturing cost from Table B. This is not the same as the amount of fixed manufacturing cost absorbed because, although actual volume deviated from budgeted volume, the fixed budget allowance remains constant. Thus the total variance on fixed manufacturing overhead is $30,000 ($220 000 absorbed minus $190,000 actual), but $20,000 of this has already been broken out in Table G. The $1,611,000 total manufacturing cost (Table H) differs from the $1,614,000 standard cost of goods sold (Table A) because of the $19,000 net unfavorable deviation from standard manufacturing cost (shown both in Table A and Table H), less the $16,000 absorption in sales volume shown in Table G.

Price variances are normally accumulated for broad aggregates, such as an entire plant, and segregated according to major types of expenditure. For example, a separate materials **price variance** may be shown for each major purchased materials item, whereas a single wage **rate variance** may be shown for the entire plant. **Quantity variances**, on the other hand, are usually accumulated by responsibility unit within each manufacturing plant. They should be analyzed for causes and reported in as fine detail as is necessary to meet the control information objective. (See section on Analysis and Control of Standard Cost Variances.)

Deviations in Nonmanufacturing Expenses. Selling and administrative expenses deviate from planned levels because of changes in spending plans, salary and price changes, volume variances, and deviations from planned efficiency. The effect of deviations in volume is reflected in the variable profit variance shown in Table E. The remaining deviation may be summarized, as in Table I.

TABLE I. DEVIATIONS IN NONMANUFACTURING COSTS
(Dollars in thousands)

	Budget at Actual Sales	Actual Expense	Profit Deviation
Variable nonmanufacturing expense......	$112	$122	($10)
Fixed nonmanufacturing expense........	250	244	6
Total	$362	$366	($ 4)

These deviations are normally accumulated by **responsibility unit** in administrative and sales organizations. If head office expenses are allocated to branches or other subordinate units, the deviations of actual expenses from budgeted **allocated expenses** should be separated from the deviations of direct **local expense.**

Summary of Deviations. The profit deviations in the illustration which has been presented, when added together, account for the entire $69,000 by which actual results fell short of plan, as shown in Table J.

TABLE J. SUMMARY ANALYSIS OF PROFIT DEVIATIONS

Favorable profit factors		
Greater aggregate sales volume (Table F)	$84,000	
Fixed manufacturing cost overabsorption, net (Table G)	4,000	$ 88,000
Unfavorable profit factors		
Lower average selling prices (Table D)	80,000	
Poorer product sales mix (Table F)	54,000	
Above-standard prices for materials, labor, and services (Table H)	13,000	
Above-standard quantities in manufacturing expense (Table H)	6,000	
Above-standard nonmanufacturing expense (Table I)	4,000	157,000
Net unfavorable profit deviation from plan (Table A)		$ 69,000

Differential Profit Analysis

DIFFERENTIAL PROFIT AND COST. A substantial part of cost accounting is designed to identify and determine the total cost associated with some costing unit—a department, a cost center, or a unit of product, for example. Another and extremely important aspect of cost relates to the question of what will happen to costs if a certain course of action is undertaken. The concept that relates to questions of this type is the concept of **differential profit** or, in a limited case, **differential cost.** Differential cost analysis provides what is probably the most useful information furnished from cost accounting sources, since it shows the fundamental causes of profit and of loss under either actual or hypothetical circumstances.

PROBLEMS OF DECISION MAKING. The process of decision making is essentially a process of choosing among competing alternatives, each of which has its own combination of investment, revenues, and costs. If there is no alternative, there is no need for a decision because there is no room for choice. These situations are fortunately rare, however, and alternatives must be compared so that management can choose the most advantageous course of action on the basis of the data available. **Problems of alternative choice** include make-or-buy, depth of processing, selection of product mix, selection of sales territories, selection of distribution channels, adoption of new products, abandonment of old products, and continued operation at a loss. Knowledge of cost-volume-profit relationships can provide substantial assistance in differential profit analysis of problems of alternative choice because the alternatives frequently differ in total volume and in the composition of volume.

DEFINING DIFFERENTIAL COSTS. Periodic reports showing the costs associated with a particular department, product, or other segment of the business are **absolute** costs, or **average** costs; i.e., they represent the total of all costs traced or allocated to that segment. The costs relevant to problems of alternative choice, however, are neither absolute nor average but **differential** costs.

Conflicts in Terminology. Several terms have come into common usage in connection with the comparative analysis of costs and profit. Economists generally use the term **marginal cost** to describe the increase in total costs, starting from a given level of output, that results from the production and sale of an additional unit of output without expanding the firm's production or distribution facilities. The economist generally assumes that marginal cost increases as output increases beyond a certain point, due to the application of the **Law of Diminishing Returns.** Therefore the complete description of a marginal cost must specify not only its amount but also the level of activity for which it is computed. Parenthetically it should be pointed out that some economists have questioned the assumption that marginal costs rise materially over most of the output range. Sometimes there is little evidence of a change in marginal cost with a change of volume within the output ranges studied.

Variable cost in economic terminology is used to describe, for any volume of output, either the **total** of the costs that vary in response to volume changes or the **average** of these costs per unit of output. In either case, the volume level must be specified. Because marginal costs represent the change in total variable cost in response to a single added unit of volume, then it follows that average variable cost must change if marginal cost changes with changes in volume.

Incremental cost is a broader concept. Dean (Managerial Economics) defines incremental costs as "the additional costs of a change in the level or nature of activity." An alternative definition would be that any cost that changes as a result of a contemplated decision is an incremental cost relating to that decision. Incremental costs include many costs that are normally classified as fixed or semifixed and may be regarded as the general class of which marginal costs are a narrow part, for the marginal costs refer to a single kind of increment only, i.e., the addition of another unit of output to fixed plant.

The converse of incremental cost is **sunk cost,** defined as a cost that will not change in real terms no matter which of two alternatives is selected. Dean (Managerial Economics) points out that sunk costs are not necessarily restricted to amortizations of historical costs; they may include cash costs, such as the president's salary, in the analysis of changing product mix or plant abandonment.

Accountants, on the other hand, frequently do not distinguish between marginal and variable costs. If they recognize a distinction in concept, they tend to assume that **average variable** cost is equal to **marginal** cost at all output levels and that both are constant for the relevant portions of the output range.

The term **differential cost** is generally used by accountants to describe the same costs that the economist calls "incremental." Occasionally the term is incorrectly applied to cover only variable cost. Differential costs are defined by the AAA Committee on Cost Concepts and Standards (Accounting Review, vol. 27) as "the increases or decreases in total cost, or the changes in specific elements of cost, that result from any variation in operations." Kohler (A Dictionary for Accountants) indicates that the terms "differential," "incremental," and "marginal" costs are often used interchangeably. In this section the terms "incremental" and "differential" will be used interchangeably to describe any costs, fixed or variable, direct or indirect, that will change in real terms as a result of a choice between two alternatives. These differential or incremental costs have five important characteristics that distinguish them from absolute or average costs:

1. **They are limited to those cost items that will change as a result of the choice of one alternative instead of another.**
2. **They must reflect only real differences in cost.**

3. They relate to the future, not to the past.
4. Their composition will vary, depending on the nature of the problem and the alternatives under review.
5. They are not precisely comparable in most cases to any cost classification included in the company's records.

Exclusion of Unaffected Cost Items. In incremental analysis, what matters is which costs will change as a result of a decision and by how much—not what their total level will be. This means that in an incremental analysis, it is possible to filter out as irrelevant any cost elements that will not differ among the alternatives being compared. This cuts down the mass of detail in the analysis and focuses attention more sharply on the items that do matter. For example, in studying the desirability of a proposed change in material specifications to reduce spoiled work and rework costs, a long list of manufacturing costs can be ruled out from the outset as having no bearing on the decision.

Limitation to Real Differences. The cost differences must be real differences, not merely apparent differences that result from methods of accounting for costs incurred. For example, if the company owns some obsolete equipment that has no scrap or market value but which is not fully depreciated on the books, the reduction in the periodic depreciation charge that would result from scrapping the equipment is not a real difference in cost and should be ignored in the cost comparisons. Or, if company-wide fixed administrative expense is allocated to product divisions in proportion to sales volume, differences in the amount of expense thus allocated are not real differences in the comparison of the incremental profits of alternatives with differing sales volumes.

Emphasis on Future Costs. Selection among alternatives is a forward-looking process, and the costs and revenues that are relevant to this process are differences among the alternatives in future costs and revenues. Actual historical costs or standard costs may be useful in the projection of future costs, but they cannot be used without adjustment unless future conditions can be assumed to be identical with those prevailing in the past.

Impact of Different Purposes. One of the widely quoted axioms of modern cost accounting is that which states that different costs are required for different purposes. To quote Vatter (NAA Bulletin, vol. 35): "Cost figures may actually be misleading if they are computed to fit one purpose but are used for another purpose." The nature of the problem and of the alternatives will determine the **specific cost elements** that must be examined. For example, in an analysis of the effects of changing the rate of output of a given product, many of the fixed costs associated with that product can be safely ignored. In a study of the profitability of continued manufacture of the product, however, it must be recognized that some of these fixed costs are also costs that will be avoided if the manufacture is discontinued. If relatively small shifts in output are contemplated, changes in supervisory costs may not be relevant, whereas if large output differentials are in question, the estimate of supervisory costs definitely must be reviewed. If the different outputs can all be achieved within the limits of single-shift capacity, it may be safe to assume a constant variable cost per unit, but if one or more of the alternatives entails the use of overtime or multiple shifts, then overtime premiums and shift differentials must enter into the analysis.

Conflict with Accounting Classifications. Differential cost classifications seldom coincide with cost classifications embodied in the formal accounting records. The essence of differential cost analysis is comparison, and differential

cost classifications are comparative classifications. **Accounting records**, on the other hand, embody the concept of absolute or average costs, and cost classifications are drawn on this basis. For this reason the determination of differential cost and differential profit requires special analysis. Routine accounting records can and must be consulted in this analysis, but they cannot be permitted to constrict and define the cost elements that are to be evaluated.

Differential costs come closest to historical cost classifications when the study is designed to question the continued operation of a segment of the company's operations. Even here, however, some of the costs recorded for the segment will be unchanged or only partly affected by the decision; for example, depreciation and the segment's allocated share of indirect fixed costs. Costs saved by closing down one segment may be offset by increased costs elsewhere as other segments step up their volume to perform necessary functions previously provided by the closed segment. Two or more product lines may be interdependent, so that the costs and revenues associated with one product will feel an impact of changes in the volume of another.

Furthermore the effects of a decision are frequently clouded by other changes that were not a result of the decision but took place independently at the same time. For example, a cost reduction project may be initiated just as a general wage rise becomes effective, so that operating costs do not fall as anticipated. The cost savings are there, nevertheless, because the bench mark for comparison is not what happened in previous periods but rather what would have happened in this period if the project had not been undertaken.

TYPES OF DECISION-MAKING PROBLEMS. Problems that call for incremental analysis may be divided for convenience into two categories, those involving a **capital investment** aspect and those that do not. Pricing problems (discussed in section on Special Cost Analyses) may fall in either category. Those pricing problems that relate to the utilization of existing investment can be studied by methods that are not appropriate to investment decisions.

Investment Decisions. Investment decisions require a comparison of investment outlays in one or more time periods with the benefits to be received in other time periods. Typical investment problems include facilities expansion, plant abandonment, cost reduction expenditures, and equipment replacement. The hallmark of an investment decision is that it commits the company to a package of outlays and receipts through time; once the decision is implemented, the company is bound to the investment outlays embodied in the chosen alternative. A typical **plant expansion proposal**, for example, may carry the following time flow of net cash outlays and receipts:

Time Period	Cash Inflow (+) or Outflow (−)
0	−$100,000
1	+ 20,000
2	+ 30,000
etc.	etc.

The $100,000 cash outflow may refer to the construction cost of an addition to the factory, the installed cost of new machinery for the addition, and any additional working capital required to support expanded production in the enlarged facilities. The cash inflows of $20,000, $30,000, etc., occurring in the first, second, and later years of operation of the added facilities, represent the revenues from added sales made possible by the enlarged capacity less the added cash costs and

expenses that would be necessary to manufacture and sell the additional goods. If additional capital outlays are anticipated for later years, these should be introduced into the time table as minus values to show the estimated **patterns of cash flows** associated with the plant expansion proposal.

In this illustration the alternatives are to expand or to continue operations at the present scale. The **net cash flow** is determined by comparing the cash flows that would prevail under each of these two possibilities. Other alternatives could be introduced, embodying different kinds and degrees of expansion; one alternative may even be to discontinue operations entirely. In each case the cash flow on which the investment analysis should concentrate is the differential between two alternatives.

The investment aspect of some problems frequently is not readily apparent. In any analysis the question should be asked whether the alternatives under study entail differing amounts of inflows and/or outflows, timed so that in the differential analysis some time periods show net inflows and others show net outflows. For example, a company with a depleting asset which has nine years of remaining life at current consumption may wish to compare varying rates of exploitation of the asset. At current rates, the net cash inflow (revenues from sale less cash costs and expenses required to produce these revenues) is $20,000 a year for nine years. At higher exploitation rates the net cash inflow could be $40,000 a year but would last only four years. The cash flows in this problem could be compared as shown in the accompanying time table.

Time Period	Cash Flow Rate A	Rate B	Difference
1	+$ 20,000	+$ 40,000	−$20,000
2	+ 20,000	+ 40,000	− 20,000
3	+ 20,000	+ 40,000	− 20,000
4	+ 20,000	+ 40,000	− 20,000
5	+ 20,000	0	+ 20,000
6	+ 20,000	0	+ 20,000
7	+ 20,000	0	+ 20,000
8	+ 20,000	0	+ 20,000
9	+ 20,000	0	+ 20,000
Total	+$180,000	+$160,000	+$20,000

In this case, the $20,000 per year lower receipts under the first alternative in the first four years must be offset against the $20,000 per year greater receipts in the last five years. To put it another way, it is necessary to "invest" $20,000 a year for four years by accepting a lower cash flow during that period in order to obtain "earnings" in the form of greater cash flows in the fifth through the ninth year. This is an investment problem. To solve it, it is necessary to find out whether the slow rate of exploitation produces enough additional cash flows in later years to cover interest charges on the amount of cash flows foregone in the early years

Tactical Decisions. Noninvestment decisions, sometimes called "tactical" decisions because they are subject to frequent revision, do not need to consider the time element explicitly. To be sure, any operating decision made today will have some influence on the course of the business in the future, but the major characteristic of the tactical decision is that it can be based largely on expected results within a relatively short period of time. Selection of **product mix,** for example, can generally be based on comparisons of the probable profits during the planning period under various potential product combinations. If the decision turns out

to have been in error, no costly investments will have to be scrapped. Decisions of this type include questions of how much of what to produce, how to produce it, and how and where to market it.

Another way of stating this is to say that for tactical decisions, the algebraic signs in the difference column of the time table are either assumed to be the same for all time periods or a selection of one alternative now can be assumed to have no appreciable offsetting effects on the cash flows of future periods. For example, if increasing the production ratio of canned hams to smoked hams in a packing plant will increase this year's profit, it is immaterial that next year it may be more profitable to sell a greater proportion as fresh or smoked hams, provided that no additional investment is required to provide additional canning facilities today. A decision of this type today does not constrain management's freedom of choice tomorrow.

METHODS OF INCREMENTAL ANALYSIS. Application of the incremental approach requires adapting the method to the nature of the specific problem, but the variation necessary is relatively small.

General Procedure. In carrying out an analysis designed to facilitate **tactical decision making,** the following general procedure is suggested:

1. Identify and describe the alternatives.
2. Determine what cost and revenue elements will be affected by the decision.
3. Estimate the level of these cost and revenue elements under each alternative.
4. Compare the alternatives.
5. Select the highest profit alternative.
6. Consider intangible factors that may favor a lower profit alternative.

When a differential **investment aspect** is present, the analysis is more complex. The comparison of alternatives must consider differences in timing of costs and revenues as well as differences in total amount. Furthermore the **imputed interest** costs of capital tied up must be considered, either explicitly in the comparison of alternatives or implicitly in the design of the criterion for selection. For example, Dean (Harvard Business Review, vol. 32) suggests that the various aspects of project profitability may be summarized in an estimated rate of return on investment, defined as the interest rate, that discounts all cash flows to a zero present value, in which case the cost of capital may be embodied in a **minimum rate of return** selection criterion. Lorie and Savage, on the other hand (The Journal of Business, vol. 28), recommend that a **cash-flow discounting procedure** be used to charge each alternative with capital costs on investment tied up under that alternative and that the alternative with the highest present worth be accepted.

If Dean's approach is adopted, a further step is required. It is not enough to compare all the alternatives with a common base, such as current profits and investments, and then select the alternative that promises the highest rate of return. The various alternatives must be considered in sequence of increasing investment commitment, and each **investment increment** must provide a return in excess of the capital costs associated with that increment. For example, three alternatives could promise over-all rates of return of 20 percent, 30 percent, and 25 percent on outlays of $100,000, $200,000, and $350,000, respectively. It may be good business to accept the $350,000 alternative, even though it promises a lower total rate of return than the $200,000 alternative, if the differential investment of $150,000 ($350,000 minus $200,000) provides a differential rate of return in excess of the cost of capital employed. To state this in another way, if rate-of-

return comparisons are used, the alternative must be considered in pairs, the "surviving" member of the first pair becoming the bench mark for evaluation of the next alternative, and so on. (For further discussion of investment problems, see section on Special Cost Analyses.)

Estimating Differential Cost. Differential cost estimates can be derived either from analysis of unit costs or from a comparison of totals of the relevant cost elements. The fact that **average unit cost** varies with volume suggests that comparison of total differential costs is generally the simpler method.

These methods of estimating differential costs are illustrated by two cases. The first case concerns a choice between two or more **levels of output** of a given product or product line. In this case the cost differential can be found by multiplying the increment in volume by the variable cost per unit and adding any changes in fixed cost that will accompany the change. Changes in fixed costs must be considered because the definition of what is "fixed" must be based on an assumption as to the **probable range of volume.** If the proposed change will extend volume beyond this range, total fixed costs will have to be stepped up or reduced. For example, in increasing output from 10,000 to 12,000 units a month, total differential costs would be computed as follows:

Increase in material cost, 2,000 × $1.12	=	$ 2,240
Increase in labor cost, 2,000 × $4.15	=	8,300
Increase in manufacturing overhead		3,000
Total increase	=	$13,540
Cost of each additional unit	=	6.77

The **unit cost approach,** on the other hand, starts with the average total cost per unit, including a share of fixed costs, and then adjusts this for over- or underabsorption of fixed overheads at the proposed new volume. This procedure is not only unwieldy but in many cases it can also yield incorrect figures. For example, the unit cost of a product may be estimated as:

Direct materials	$1.12
Direct labor	4.15
Manufacturing overhead	3.18
Total product cost	$8.45

The manufacturing overhead cost estimate is based on production of 10,000 units per month. An increase in output to 12,000 units per month would increase manufacturing overhead to $34,800 per month, resulting in a new average rate of $2.90 per unit and a new average total cost of $8.17. The new average is not relevant, however, because the decision to increase output should be based on the differential effects of the change and not on its effect on averages.

Schlatter and Schlatter (Cost Accounting) point out that the response of costs to volume may be different when volume is increasing than when it is falling. As long as physical plant facilities remain the same, costs frequently respond slowly to volume changes, particularly on the downswing. Built-in rigidities, together with a reluctance to accept the fact of reduced volume, tend to produce a cost path on the downswing that is higher than the one followed on the way up. Even the variable costs, as NAA Research Series No. 17 (NAA Bulletin, vol. 31) points out, "are not automatically variable with volume and do not follow volume closely unless management exercises control over them." Estimates of cost differentials in connection with volume changes must recognize this fact.

Differential Cost of Change in Product Mix. A different aspect of the cost-volume relationship enters when the problem is to choose among different product-mix combinations, totaling approximately identical volumes. Once again the answer is not provided by adding total unit costs for the various products. For example:

	Product A	Product B
Materials	$1.12	$ .80
Labor	4.15	6.20
Manufacturing overhead	3.18	5.00
Total	$8.45	$12.00

The present product mix of 10 000 units of A and 5,000 units of B completely absorbs manufacturing overhead of $56,800. A shift in product mix to 8,000 units of A and 6,400 units of B would leave total labor costs at approximately the same level and would slightly increase total overhead absorbed, as shown by the following data:

	Mix 1			Mix 2		
	A	B	Total	A	B	Total
Materials	$11,200	$ 4,000	$ 15,200	$ 8,960	$ 5,120	$ 14,080
Labor	41,500	31,000	72,500	33,200	39,680	72,880
Manufacturing overhead absorbed	31,800	25,000	56,800	25,440	32,000	57,440
Total product cost	$84,500	$60,000	$144,500	$67,600	$76,800	$144,400

This would indicate a differential cost of only $100 per month in favor of Mix 2, a sum so small it could be disregarded. A study of the relationships between production and manufacturing overhead, however, reveals that variable overhead is $0.70 for Product A and $2.80 for Product B, largely because Product B requires large costs for power, rework, and factory supplies. This means that the total variable costs for Product A are $5.97, and for Product B, $9.80. Total variable product cost under Mix 1 are thus $108,700, and under Mix 2 are $110,480, a difference of $1,780 in favor of Mix 1. Furthermore, added inspection costs of $500 a month would be necessary to boost output of Product B to 6,400 units, so that the total differential manufacturing cost would be $2,280 per month.

Approaching differential cost analysis in this fashion has the advantage of concentrating attention on the changing elements of cost. Costs that will be fixed with respect to the alternatives under review are excluded from the calculation. It would be possible to show for each alternative the total costs associated with that alternative, but this would increase the amount of detail and clerical work required without affecting the end result.

APPLICATIONS OF DIFFERENTIAL COST ANALYSIS. Incremental analysis can be applied to a wide variety of problems. The method of application, however, can be illustrated by examples of the three following types: (1) continued operation at a loss, (2) depth of processing, and (3) addition of a new product.

Continued Operation at a Loss. One question that frequently arises is what to do when a segment of the business reports a loss. There are two possibilities: (1) The loss may be due to a temporary drop in demand, in which case the problem is whether to produce for inventory or shut down temporarily and reopen

when demand revives; or (2) the loss is likely to continue for a substantial period, in which case more permanent adjustments may have to be made. These adjustments may be to adjust the company's pricing policy, to search for ways to reduce costs or expand markets, to search for substitute products, or possibly to abandon this segment of the business entirely and dispose of the facilities now devoted to it.

The first question that should be asked in any such situation is how the loss is computed. To illustrate, a company manufactures a line of hard rubber containers for industrial use. Recent developments of substitute materials have reduced the price of these containers to $2.00 and sales to 200,000 units a year. The profit report of the Container Division shows the following data:

Sales		$400,000
Cost of goods sold		
Variable	$300,000	
Fixed	75,000	375,000
Gross margin		$ 25,000
Division selling and administrative expense		50,000
Net loss		($ 25,000)

Variable production costs are expected to remain constant for the next year at $1.50 per unit. If the division were to go on stand-by status, $30,000 of the fixed manufacturing overhead and $15,000 of the division's selling and administrative expense could be avoided. The **net loss at stand-by** therefore would be $80,000 ($45,000 fixed manufacturing overhead and $35,000 division selling and administrative expense). The **incremental profit** from continuing operations at the present level would thus be $55,000 ($80,000 stand-by loss minus $25,000 operations loss), and it would be profitable to continue operations until additional or substitute products or markets could be found to absorb the excess capacity and high fixed costs of this division.

It could, however, be even more profitable to cease operations altogether and dispose of the facilities utilized by this division. Shillinglaw (Journal of Business, vol. 30) points out that this is an investment problem which could be handled in the following way: In this case investigation shows that $28,000 of the fixed manufacturing overhead represents depreciation of plant and equipment and that $10,000 of selling and administrative expense would still be incurred to carry out continuing functions now being performed by Container Division personnel. The costs that could be saved by abandoning this division are therefore $387,000 ($347,000 manufacturing costs + $40,000 selling and administrative costs); the lost gross revenues would total $400,000. The question, therefore, is whether the division's facilities could be sold for a price that, reinvested elsewhere within the company, would produce profits in excess of the $13,000 a year that would be lost if this division were to be scrapped.

This analysis has been simplified to illustrate the approach. It should be modified further to consider the possibility of improving the division's future profit either by finding new products or by effecting economies in methods of manufacture or of distribution. A complete study would also have to consider the effect of severance pay and other termination costs. It should determine whether the Container Division production could be transferred to other company facilities or whether discontinuance of this line would affect the sales of other company products. In addition, calculations of return on investment should be made on an after-tax basis. But the essential fact remains that a more complete and more realistic view of the **profitability of operations** is obtained when these operations

are examined from an incremental standpoint rather than through an examination of absolute costs and profits.

Depth of Processing. The problem of the most profitable depth of processing can be solved largely by estimating whether the added cost of processing the product one stage farther will be accompanied by an even greater increase in revenues, assuming no additional investment requirement. For example, a manufacturer markets a line of souvenir banners and a line of souvenir pillows, using the banners as covering material. He now sells the banners at $4.80 a dozen and the covered pillows at $9.00 a dozen. The manufacturer estimates that he can sell 700 dozen additional covered pillows per month with no increase in selling and administrative cost but at a reduction of 700 dozen in sales of banners. The purchase cost of pillow materials other than the banners is $3.00 per dozen, and additional direct labor is $1.20 a dozen. The increase in manufacturing overhead cost is estimated from the following flexible budget totals:

Total labor hours	7,000	7,500	8,000	8,500
Total factory overhead	$ 900	$1,000	$1,100	$1,500

The factory is now operating at 7,500 labor hours, and if 700 dozen banners are processed into covered pillows, 8,000 labor hours will be required

Incremental revenue, 700 × ($9.00 − $4.80)		= $2,940
Incremental cost		
Added direct labor and materials, 700 × ($3.00 + $1.20)	= $2,940	
Added overhead ($1,100 − $1,000)	= 100	3,040
Incremental loss		= $ 100

In this case it is more profitable to maintain the existing product mix and sell the banners as banners without further processing of them into pillows.

The limitations of flexible budget data for estimating incremental costs should be recognized. For example, 500 extra direct labor hours on pillows may increase factory overhead by $100, but the increase may be $500 if poplin jackets are added to the line.

Many depth-of-processing problems presume a fixed quantity of some basic material. The problem is frequently more complicated, however, because it is possible to increase the sale of a later stage product without curtailing the sale of prior stage products. For example, the souvenir manufacturer might have been able to expand the sale of pillows without cutting into his market for banners. This means that he would have had to manufacture 700 dozen additional banners at, say, an incremental cost of $2,100.

Incremental revenue		
Sale of 700 dozen pillows at $9.00		= $6,300
Incremental cost		
Added production cost, banners	= $2,100	
Added production cost, pillows (per above computation)	= 3,040	5,140
Incremental profit		= $1,160

Adding a New Product. To illustrate the application of incremental analysis to the problem of adding a new product to an existing line, the example here has been adapted from Lang–McFarland–Schiff (Cost Accounting). To simplify the illustration, it will be assumed that no additional investment, other than that necessary to provide adequate working capital for the new line, is required.

The Specialty Manufacturing Company produces a single product, Product A. Its **monthly income statement**, projected for the coming year, is as follows:

	Per Unit		Total	
Sales, 80,000 units		$2.75		$220,000
Cost of production				
Direct materials	$.50		$ 40,000	
Direct labor	.50		40,000	
Variable overhead	.25		20,000	
Fixed overhead applied	.75		60,000	
Total cost applied		$2.00	$160,000	
Underabsorbed manufacturing overhead			15,000	
Cost of goods sold				175,000
Gross margin				45,000
Selling and administrative expense				18,200
Net profit before taxes				$ 26,800

The company is contemplating the addition of a new item, Product B. It is estimated that 40,000 units of Product B can be sold each month at a price of $1.75, but that additional selling expenses of $8,000 a month will be necessary to secure this volume. The variable manufacturing costs of Product B are estimated at $1.10 per unit, including labor, materials, and variable overhead. Fixed costs will be increased by $5,000 a month. The **incremental profit** from this product can be calculated as follows:

	Per Unit	Total	
Sales, 40,000 units	$1.75		$70,000
Differential cost of production			
Variable	1.10	$44,000	
Fixed		5,000	49,000
Differential gross margin			$21,000
Differential selling expense			8,000
Differential profit			$13,000

Further investigation indicates that additional working capital of $50,000 would be necessary to carry the expanded sales volume. The rate of return on this additional investment would therefore be approximately 26 percent before taxes ($13,000/$50,000), which is in excess of the minimum capital return required by the company.

The analysis would be different if the idle capacity in the factory were temporary. Under the conditions assumed, this would not be serious inasmuch as the only additional investment required was in working capital which could presumably be transferred if subsequent increases in the demand for Product A were to remove the capacity available for Product B. At that time a new decision would have to be made as to whether the profitability of Product B was adequate to justify additional capacity investment. Effects on the sales force and on customer relations would also have to be examined under these conditions.

ESSENTIALS OF DIFFERENTIAL PROFIT ANALYSIS. These illustrations point up the essential diversity of incremental profit analysis. This analysis can be applied to many situations and in each situation requires a slightly

different combination of data and calculations. But a few general points can be summarized:

1. The raw data of incremental profit analysis are the cost, revenue, and investment elements that will be affected by the decision toward which the analysis is directed.
2. The amount of the differential is the amount of change in the elements subject to change, and the differentials are measured from some common base position (for example, present level of output).
3. In investment problems, cost, revenue, and investment differentials are first measured from some common base position, but the alternatives must then be compared in pairs in order to determine the appropriate depth of investment.
4. The criterion in tactical decisions is to find the alternative which shows the greatest difference between added revenue and added cost, measured from the common base.
5. Differential costs per unit are not necessarily constant for all ranges of volume; the nature of the problem will indicate the specific relation of cost to volume that should be used.
6. Only real changes are to be considered; changes that result solely from bookkeeping conventions should be excluded from the analysis.
7. Differential costs are best estimated by studying the total of the elements of differential costs rather than costs per unit.

The careful observation of these principles should shorten the special analyses underlying decisions of alternative choice and make them more closely relevant to the questions under review.

SECTION 19

SPECIAL COST ANALYSES

CONTENTS

CONTENTS (*Continued*)

SECTION 19

SPECIAL COST ANALYSES

Return on Investment

USES OF RETURN ON INVESTMENT. Mackenzie (Harvard Business Review, vol. 35), in summarizing the literature on return on investment, groups the uses of the concept in the following three broad categories:

1. Measuring operating performance
2. Evaluating and controlling capital investment projects
3. Profit planning.

Livingston (NAA Bulletin, vol. 38) lists the most common uses of the return on investment index as follows:

1. Analysis of stockholders' return on equity in the business.
2. Analysis of profits by operating divisions.
3. Analysis of profits by product lines.
4. Pricing of new products.
5. Analysis of major cost areas in a cost-reduction program.
6. Study of product and process development.

The **analysis of profitability** by operating divisions or by product lines is essential to the control of decentralized operations. Typical of the trend toward decentralization is the experience of the Ford Motor Company as expressed by Breech (Planning the Future Strategy of Your Business, Bursk and Fenn, eds.):

> One of our first steps back in 1946 was to set up a modern organization featuring a program of decentralization—breaking up our business into many smaller profit centers, each run like an independent business held accountable for its profit performance. Along with this process naturally went the delegation of responsibilities to managers and the authority necessary to carry out those responsibilities.

The use of return on investment information in **pricing** of product to outside enterprise and of intra-company transfer is discussed elsewhere in this section. **Cost reduction** as well as **product development** studies follow upon a recognition of those segments of a business showing poor return on investment.

MEASURES OF PERFORMANCE. Although accountants have always concerned themselves with balance sheets and income statements, it is only in recent years that the key measurement of operating performances has shifted from profit on sales to profit on assets employed or on investment. The failure to stress investment in measuring performance is reflected in the following comment by Read (NAA Bulletin, vol. 35):

> This has produced the anomalous situation in which those who supply the money for a business are expecting a result measured on one basis while those who employ the money are striving for a result measured on another.

This can result in serious misplanning. A failure on the part of operating managements to relate volume and profit performances to the capital required to produce it can easily result in excessive plant investment and abnormally high inventories. Also, in cases in which several lines of product are produced by the same company, the emphasis given the various lines can be badly planned if margin constitutes the only basis of measurement.

Security analysts have from the start used profit related to net worth as one of the important tests in evaluating corporate performance. In judging performance for internal control and decision making, however, the traditional measure has been profit on sales.

RETURN ON INVESTMENT MEASURE. Attention to return on investment as a measure of performance has recently increased. Kline and Hessler of E. I. du Pont de Nemours & Co., one of the first corporations to employ return on investment as a control tool, write (NAA Bulletin, vol. 33):

> It is our considered opinion, which has been critically re-examined many times over three decades, that a manufacturing enterprise with large capital committed to the manufacture and sale of goods can best measure and judge the effectiveness of effort in terms of return on investment.

Even more recently, Kutvirt (NAA Bulletin, vol. 38) has declared, "The return on investment as an indispensable tool of modern, managerial decision making is fully established," and Keller (Management Accounting for Profit Control) observes:

> A few American corporations have used return on investment or capital employed for measuring and controlling profits for many years. As a result they have been unusually successful. . . . With this demonstrated record of effectiveness of profit measurement and control it is difficult to understand why companies have been so slow in using it. It is only recently that it has been receiving increased attention and has begun to be used by a growing number of companies.

The following changes in American business organization and economic environment have resulted in more frequent application of the return on investment measure:

1. Organizational change employing the decentralized autonomous division.
2. Capacity or near-capacity operations.
3. High cost of capital.

With divisional managers having full responsibility for operations, it becomes essential that they take the over-all company view of returning a profit on the investment left in their charge, rather than merely earning profits on sales independently of the investment risked. Where investment dollars are difficult to secure, it becomes imperative that every dollar invested produce a maximum return.

RETURN ON INVESTMENT FORMULA. The return on investment formula may be stated as follows:

$$\frac{\text{earnings}}{\text{sales}} \times \frac{\text{sales}}{\text{investment}} = \text{return on investment}$$

Accordingly, a company with $10,000 in earnings, sales of $100,000, and investment of $200,000 would yield return on investment calculated as follows:

$$\frac{\$\ 10.000}{\$\ 10,000} \times \frac{\$100,000}{\$200,000} = 5\%$$

It is evident that the earnings related to sales is 10% and the earnings related to investment comes to 5%. If the investment in this business or department could

be cut in half, the return on investment could be 10%. Similarly, if sales doubled, producing earnings of $20,000, a return of 10% would be yielded on the $200,000 investment.

The return can, of course, be derived by merely relating earnings to investment. The use of the two fractions is suggested by a number of writers because we are dealing with two independent variables, profit on sales and turnover of investment. The final percentage of return on investment is the significant relationship, but it is felt that the full formula shown here gives management a better understanding of the elements yielding the result. As Muth (NAA Bulletin, vol. 35) expresses it:

> Obviously, we can obtain the same answer by simply dividing the net profit by the capital employed, but in so doing we would lose sight of two important factors, the significance of costs in relation to sales income and the significance of the level of capital employed in relation to sales volume—two variables which must be kept under constant study if we are to know what is happening within our operations and where managerial effort needs to be concentrated.

Problems in Return on Investment. As Heiser (Budgeting—Principles and Practice) observes:

> While the use of the return on investment concept as a tool to aid management in measuring the profitability of its operations has grown in acceptance, there is no general agreement as to what elements constitute the factors to be employed in its computation.

Many problems are encountered in the computation of return on investment, which may be grouped as follows: (1) definition of terms, (2) valuation, and (3) allocation.

DEFINITION OF TERMS. Return on investment is related to three items: sales, investment, and earnings or income. **Sales** appears in both ratios, which are multiplied to give the final return on investment expression. Determining a division's or product-group's sales is relatively simple for sales made outside the company. The problem of intra-company sales is dealt with later in this section.

Earnings. Some advocate the use of **net income** (i.e., operating income adjusted for nonoperating expenses and income items and federal income taxes) on the ground that the rate of return should be calculated on an all-inclusive basis. The more widely held view, however, appears to be to regard the earnings or income of a division or product group as described by Mackensen (Financial Management Series No. 106, AMA) as "the profit from operations before deduction of interest on borrowed capital employed and before federal income taxes." It is believed that operating management is interested primarily in the operations which they can control, and the use of the all-inclusive concept could lead to situations where substantial changes in nonoperating items would distort the rate of return.

Bierman (NAA Bulletin, vol. 39) lists the following eight problems of **income measurement** in computing return on investment:

1. Revenue recognition and the matching of expenses with revenues.
2. Treatment of repairs and maintenance costs
3. Inventory procedure. During periods of fluctuating prices income will be affected by the choice of inventory basis, "FIFO," "LIFO," average cost, etc
4. Treatment of nonproductive supplies. Should they be expenses when purchased or inventoried?
5. Choice of depreciation procedure. Are all plants using the same procedure (straight line, declining balance, sum of the years' digits, activity basis, etc.)?

6. Adjustment of depreciation for changes in the price level.
7. Allocation of joint costs, especially central office expenses.
8. Effect of changes in the level of production on income (caused by absorption costing under conditions of changes in production).

Bierman points out that there are techniques to handle all the preceding problems, but "examples can be presented showing two plants (assumed to have the same physical characteristics) which will have different rates of return on investment caused by differences in accounting treatments of one of the above items, rather than in efficiency."

Investment Base. The term "return on investment" appears to be the one most widely used in the literature for the tool discussed here. Keller (NAA Bulletin, vol. 39) expresses a preference for **return on capital** for internal use on the ground that "investment" carries the connotation of equity capital rather than total capital. He states that although the return on investment (equity capital) has some limited value as an internal measure, it is primarily an investor's guide.

Investment also is sometimes referred to as **assets employed.** Welsch (Budgeting: Profit-Planning and Control) observes that "as a general rule, assets represent the amount as shown on the left side of the balance sheet. It may be desirable to omit (a) excess cash and temporary investments, (b) permanently closed or idle facilities, and (c) construction in progress." The significant point is that the assets are included and liabilities ignored. A limited survey of the practices of a few companies, conducted by the National Association of Accountants (NAA Bulletin, vol. 35), seems to confirm this approach. The logic of this method is quite simple. Return on investment is primarily used for internal managerial control. The evaluation of the performance of a division or product group is based upon the effectiveness with which assets are employed. Where the money came from for these assets (loans, investment by stockholders, internal financing, etc.) is not relevant to the evaluation because operating managers have little control over sources of capital.

VALUATION OF FIXED ASSETS. There is considerable disagreement with regard to the valuation of **investment. Long-life or fixed assets** may be valued at **book value** (cost less accumulated depreciation), **original cost,** or **replacement value.** Ideally, current replacement values would appear to be the desirable choice. If return on investment is to be used as a measure of management's utilization of assets for any given period of time and is related to earnings during that period, then the assets should be expressed in terms of current period values and not be affected by the accident of the period of acquisition, or the particular method of depreciation used.

Replacement Cost Value. While it appears that comparatively few companies use the replacement cost value, as is evidenced by an NAA survey (NAA Bulletin, vol. 35), it is well to note that replacement cost information on long-life assets is developed by many companies for insurance purposes and could well be used for return on investment calculations. Kline and Hessler (NAA Bulletin, vol. 33) have made some trial runs on a **replacement cost** basis in return on investment computations, however, and they point out the difficulty of getting satisfactory answers on the following items:

1. What is a fair estimate of replacement cost or value of plant?
2. What depreciation provision would be proper if plant had been constructed on today's know-how and today's cost?
3. The cost of production in such plant.

4. The price level for our goods in an economy which generally dealt with "economic profit" rather than "monetary profit."
5. The company's tax picture if the whole economy were on an "economic profit" basis.

Original Cost. The NAA survey referred to in the preceding paragraph (NAA Bulletin, vol. 35) indicates that the most frequently used base for assets is original cost, at least among the small group of companies questioned. One of the most discussed questions in this field is whether assets carried at historical cost should be used in the investment base at **gross cost** or **net cost after deduction for accumulated depreciation.** Three small surveys, two by the National Association of Accountants (NAA Bulletin, vols. 35 and 39) and one by the Controllership Foundation (Return on Investment: Use of Gross or Net Assets in Computing Ratios) all disclose a considerable variation on this point. The Controllership Foundation, on the basis of its survey and a review of published material, concludes (Controller, vol. 25) that there was no general agreement on the gross versus net cost base and that the choice of a base seemed "dependent upon a number of factors, such as the use to be made of the ratio, company organization, volume of operations, and nature of the assets."

Lyon (Financial Management Series No. 111, AMA) states the case for the use of **gross cost** as follows:

In our program of expenditures we constantly make provisions for replacement and renewal of our plants. To use net plant investment, which might in some cases steadily decline for a period of years, and to relate this to pricing and profit situations could be extremely misleading, particularly at times when the plant facility has to be replaced and the investment again becomes substantially higher. We therefore decided that it was wiser to keep before us at all times the full initial cost of the operations. It should be noted that when capital items are retired and disposed of, their gross value is removed from operating investment.

Book Value. Some companies use **net value or cost less accumulated depreciation** in valuing long-life assets as an element of the investment base. MacKessen (Financial Management Series No. 106, AMA) suggests this as a desirable approach in the following words:

We take the position that the depreciation reserve represents that portion of the initial investment which has been recovered through charge-offs against operations and is re-invested in other fixed assets or is being used as working capital. To the extent that recovery and re-investment have been made, we relieve the old asset of the obligation of earning a return. Instead, we look to the new asset in which the value is now lodged for such earnings. Eliminating depreciation from the base gives a realistic investment figure which our operating people can accept without raising questions of depreciation of asset values. At the same time this treatment places a relatively greater demand for earnings on the new, modern installations than on the old, worn, and partially obsolete one.

After reviewing the arguments pro and con for the various bases of valuation, Casson (Controller, vol. 22) offers this compromise:

Investment, as used in the development of comparative statistics of returns on investments, shall be recognized as the sum of the pertinent assets used in producing the income of a company or its divisions, departments, products, processes or projects at gross book values less valuation reserves as applicable except that:

1. When book values are, in the presence of objective criteria, deemed to be unrealistic, then market values or satisfactory equivalents shall be substituted.

2. When, and only when, the purpose of the comparison is the evaluation of corporate management's ability to use funds from sources other than common equity, said sum shall be the net of the liabilities or accountabilities for those funds.

VALUATION OF CURRENT ASSETS. In addition to long-life assets, the current assets (cash, receivables, and inventories) are part of the investment base. The valuation of cash and receivables poses no problem. With regard to inventories, however, the question of "FIFO" and "LIFO" valuation must be faced. This problem is especially true in companies which use both methods for different segments of the business or different elements of inventories. It is suggested that ideally, the "FIFO" value, which approximates current market value, is the most desirable one, following the logic suggested in connection with the use of replacement cost for the long-life assets. A division manager's performance could then be judged by relating his value of the assets he manages. Prevailing procedure seems to suggest the use of a value for inventory which is reflective of the particular method ("LIFO," "FIFO," etc.) employed for regular accounting purposes.

In considering the problems of evaluating the different kinds of assets for the investment base, Keller's observation (NAA Bulletin, vol. 39) emphasizes the value of the rate of return in spite of the difficulties involved:

1. Trends are more significant than the percentage ratios.
2. Consistency is of prime importance, and the assets included and the method of their evaluation will not destroy the effective use of ratios as long as they are determined on the same basis year after year and for all measurement purposes

CAPITAL ALLOCATION. The problems encountered in allocating assets to divisions, product-groups, or any other segment of the company is not unlike the problems of allocating factory overhead to departments or marketing costs to products and customers. Precision is frequently sacrificed for a workable basis of allocation. According to Evans (NAA Bulletin, vol. 36) Westinghouse Electric Corporation uses three broad guiding principles in making allocations:

1. Joint costs and assets can be allocated to product departments serviced on any of a number of possible bases, such as productive labor hours, direct labor and materials costs, etc.
2. All assets can be assigned to one of the profit units served, preferably the one which is the largest user. Products shipped to other profit units are costed out of the responsible unit to the receiving unit. This method enables clear-cut assignment of responsibility for assets and costs but raises the problem of the basis for interdepartmental transfers.
3. The feeder department, perhaps along with other adjacent feeder departments, can be established as a completely separate unit, charged with responsibility for earning an adequate return on assets employed. This also places emphasis on establishing a proper basis for interdepartmental transfers.

Keller (NAA Bulletin, vol. 39) warns:

As with cost allocation, the basis for capital allocation to units must be developed to meet the circumstances peculiar to the company and to the units of the company. There is no one basis of allocation for each asset which is "right" for every circumstance.

Allocation of Specific Assets. Keller makes the following observations as to the generally accepted basis of allocation of a number of specific assets (Management Accounting for Profit and Control):

1. Cash is usually allocated to product lines on sales or cost of sales. Cost of sales more nearly reflects the demands for cash, since it is not necessary to finance

profit. The actual dollars of cash and government securities shown on the balance sheet may be distributed, or a standard ratio of cash to sales or cost may be applied. In the latter procedure there may be a residual or deficit of cash at the company level. Consideration is sometimes given in manufacturing companies to different products on the basis of whether they are manufactured and sold, purchased and carried on inventory for resale, or shipped from suppliers' stocks as they are sold. The first would carry the highest ratio of cash, the second a lesser ratio, and the third the least.

2. Accounts receivable are usually allocated on sales dollars, giving consideration to different credit terms on each product line.
3. Inventories of finished goods are specific by product lines. Semi-processed materials may be used for a specific line or for several lines. In the latter case they are allocated on the basis of usage. Raw materials and supplies are allocated on usage.
4. Fixed-asset values are first assigned to the operations of the company according to the location of the assets and then allocated to product lines on the same bases used to allocate the fixed expenses of those operations. This procedure is followed for production operations, sales offices, and general-office items.
5. Prepaid expenses may be considered to be covered in the ratios used for cash or may be allocated specifically according to their character, for example, prepaid property insurance on the basis of insurable values.
6. Miscellaneous assets which may be applicable to product lines can usually be assigned specifically. If not, some general allocation base is selected, or they are carried at the company level as unallocated.

RETURN-ON-INVESTMENT CHART. An effective practical tool for studying **comparative return on investment,** Fig. 1, is suggested by Read (NAA Bulletin, vol. 35). The solid line shows the combination of profit margin and asset turnover necessary to achieve a desired 20% return. The plotted points reflect the performance of the various decentralized segments; in this case, divi-

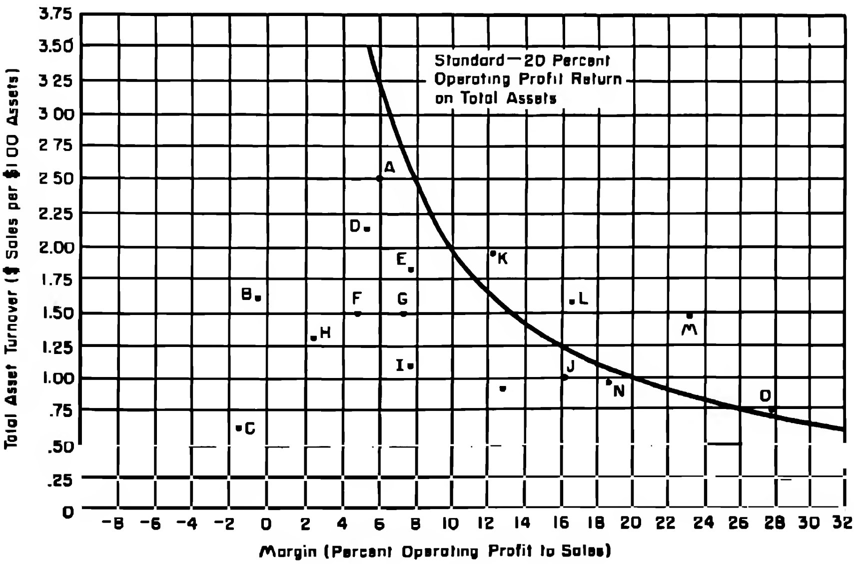


Fig. 1. Profit margins and asset turnovers by product lines.

sions of company. Read (NAA Bulletin, vol. 35) reports on the managerial use of this chart as follows:

. . . a look at Division A will be revealing. This division has a substandard asset return performance. (This is measured by the linear distance from the dot plotted for Division A and the curve representing the company standard, which in this case is a 20 percent operating profit return on assets.) In considering how it can work toward a more satisfactory return, the division manager sees that in comparison with other divisions, his asset turnover performance is the best, but his margin, at only 6 percent is below the average. He is particularly impressed by the fact that Division K, with operating and product characteristics very similar to his own, produces a return in excess of the company standard. He sees also that this is achieved by twice as favorable a margin performance in spite of a less favorable rate of asset turnover. He decides, therefore, that in his long-range planning, he will approach the problem of margin by attacking costs and operating expenses. He realizes his advantage in a better rate of asset turnover. He decides to set his margin goal to equal that of Division K, i.e., 12 percent, at the same time sustaining his turnover rate, which, if achieved, would result in a better asset return ratio than the other divisions' current performance.

CAPITAL EXPENDITURE EVALUATION. The significance of return on investment in evaluating **proposed projects for capital expenditures** is stressed by Sheehan (Financial Management Series No. 103, AMA):

The first step is to review critically our planned estimated expenditures for plant additions and replacements. All projects included therein must pass a test almost as severe and as exacting as when they are submitted for actual approval, the acid test being the return on investment.

NAA Accounting Practice Report No. 7 (NAA Bulletin, vol. 40) shows that a number of companies are using the return-on-capital-employed approach to **capital expenditure evaluation.** According to the NAA Report, while "a portion of the projects do not readily yield to dollars and cents comparisons and so must be explained by means other than increased profits . . . the majority of the capital proposals are of the 'profit-making' type." The **cash payback** or **years to recover capital** method is one of the various techniques used to measure one project against another or against a minimum standard, while another is the **percentage return on the amount expended.** The NAA Report observes that "the return-on-capital-employed approach to capital expenditure evaluation gives primary consideration to the profit contribution that a project will make" and reports several variations in the way the ratio may be calculated. (For a discussion of budgeting for buildings and equipment, see the Accountants' Handbook, Wixon, ed.)

IMPROVING THE RETURN ON INVESTMENT. The use of the rate of return on investment should lead naturally to the careful study of specific ways in which the return can be improved in the company and in individual divisions. There should be a coordinated effort by the engineering, manufacturing, and marketing departments, all aided by managerial accountants, to accomplish this result. Muth (NAA Bulletin, vol. 35) summarizes the three general ways in which the return can be improved, as follows:

1. By increasing net sales through higher prices or greater volume.
2. By decreasing costs.
3. By reducing the amount of capital employed through improvement in inventory levels, more rapid collection of accounts receivable, putting excess cash to use, and through economic control of additions to fixed capital.

Attempts to improve the return on investment lead to the question of what should be regarded as optimum and maximum return on capital employed. The establishment of a **standard rate of return** for a company or for a division is a controversial matter and requires careful judgment. The following are among the more important factors to be considered:

1. The rate of return of a number of other companies in the same industry, including some of the more successful ones.
2. The rate of return of some successful companies in other industries.
3. The position of the company, or the division, in the industry.
4. The more highly competitive the industry, the lower the rate of return likely.
5. The likelihood that new companies will enter the industry and provide additional competition if the rate is unusually high.
6. Product lines that are well protected by patents or secret processes may be expected to earn a higher return than those exposed to strong competition.
7. In many cases the standard should represent some improvement over the present rate of return.
8. In general, new capital should produce earnings which will improve the present rate of return, or at least equal it.

LIMITATIONS. Whenever a technique involving as many problems in computation and interpretation as return on investment begins to be adopted by a number of companies, there is the danger that it may be misused and misunderstood. Certain criticisms have been registered against the rate-of-return approach. Evans (NAA Bulletin, vol. 36) makes the following two specific charges against return on investment as a measure of performance.

1. A standard rate of return cannot be applied uniformly to all profit units. Differences in age of assets, depreciation policies, inventory valuation methods, etc., make this impossible.
2. Although useful for appraisal of long-term performance, profit potentialities, and long-term planning, return-on-asset standards are not usable as measures of short-term performance.

Lewis (Planning, Managing, and Measuring the Business), while granting that the rate of return may be useful within certain limits, believes that it has the specific weakness of encouraging departmental managers to concentrate on improvement of the ratios rather than improvement in the dollar profits.

Dean (NAA Bulletin, vol. 39) emphasizes the difficulties of allocating revenues and costs among divisions of a company and states that "precise measurement of internal profit is quite impossible."

A number of the strong advocates of return on investment warn of the limitations of this technique. Keller (NAA Bulletin, vol. 39) describes it as "the best common measure developed to date." He warns, however, that "no ratio can ever be substituted for managerial judgment." Edson (Controller, vol. 25) expresses the conviction that "despite its obvious limitations . . . return on investment provides the closest approach to a universally applicable measurement of management efficiency."

The figure for return on investment should not be looked upon as a clear, precise all-purpose truth which can be accepted without interpretation. It is an imperfect tool which has to be interpreted against the background of the circumstances of each individual case. Vatter, after a lengthy discussion of the many difficulties involved in computing and interpreting a rate of return under various conditions, concludes by saying (NAA Bulletin, vol. 40):

The usefulness of a rate of return depends heavily on the conditions in which it is computed and the way in which it is used. Some situations are well described by such

calculations; but others are less so, even to the extent of being uninterpretable or undependable. . . . Overemphasis on the rate of return can be as misleading as ignorance of it. Certainly, the rate of return approach should be used with the discretion that such a measure requires.

Make-or-Buy Decisions

VARIATION IN DECISION PATTERN. Keller (Management Accounting for Profit Control) describes the evaluation of the alternatives in make-or-buy and lease-or-buy decisions as "special studies which are among the most important that the managerial accountant is called upon to make." Keller makes the further observation that these decisions are not final because "competitive pressures, production methods and capacities, available working capital, and costs of borrowing are changing constantly."

In connection with decisions to make or buy, like so many other management decisions, there is no one answer suitable for all situations, nor can a company afford to play "follow-the-leader," suggesting that if its competitor decides to make and not to buy, it would be desirable in its own situation as well. Higgins (Harvard Business Review, vol. 33) illustrates this point by referring to the automobile industry. In one recent year General Motors paid 53% of each sales dollar to outside suppliers, Chrysler paid 66% and Studebaker paid 73%. Ford, at the other extreme, was far more self-contained.

Methods of Decision Making. Whether it concerns processed raw materials, supplies, component parts, or finished products, the decision to make or buy may sometimes involve top management or may be delegated. Culliton (Make or Buy) observes:

Like all management problems, make-or-buy problems may be broken down into parts, and authority delegated among various executives . . . One coordinating executive . . . would be required only when fundamental make-or-buy issues are being decided. Many of the more routine decisions may well be made by individual executives in the lower ranks, provided those decisions are within broad general limits set up by higher executive authority.

A committee approach to decisions on make or buy is suggested by Brinkerhoff (AMA Special Report No. 17). In his company, a **purchase-make committee** has been established, including representatives from production planning, quality control, engineering, methods and standards, cost accounting, mechanical processing, and purchasing. It is apparent that the top management of this company determined the specific parts which should be subject to make-or-buy study and then delegated to the committee the task of making each decision.

COMPARATIVE COST STUDIES. There are a number of variations in the form which make-or-buy studies take. In some cases a **complete set of cost figures** is prepared for the whole company for each of the proposed alternatives. A shorter method is to limit the cost study to the particular area directly affected by the decision. A third method is to use **differential or incremental costs** (described in the section on Cost-Volume-Profit Relationships). Basic to all these methods is the distinction between **fixed and variable costs** (discussed in the sections on Accumulation of Manufacturing Overhead and Cost-Volume-Profit Relationships). To the extent that the fixed costs are fully fixed and the facilities cannot be used for other purposes, they are ignored in the cost comparison.

Keller (Management Accounting for Profit Control) emphasizes the need to determine the effect of make-or-buy decisions on the company as a whole as well as on the division directly affected. For example, there are cases where the gain to

Division A from buying a part on the outside at a lower cost would be more than offset by the drop in profits suffered by Division B which formerly supplied Division A with the part in question. Keller also points out the error frequently made of calculating the changes in direct costs correctly but of continuing to use existing rates and ratios to determine the effect on other areas. This practice ignores the changes in the total of indirect manufacturing costs and administrative expenses, the shift in cost allocations among product lines, and the changes in fixed and working capital that are caused by a decision to change from manufacturing to buying, or vice versa. Keller urges the use of **return on investment** in these computations because the differences in investment required by the make or buy alternatives may be significant.

Brinkerhoff (AMA Special Report No. 17) illustrates in Fig. 2 a rather detailed produce-or-make comparison used by Argus Cameras, Inc. The individual steps involved in preparing the report follow:

Section 1

Constant data.

Machine code, vendor, RM code, self-explanatory.

A. Given on routing sheet.
B. Found by weighing the parts.
C. Subtract **B** from **A**.
D. Average price received from scrap dealer.
E. Move decimal two places left in data given in line **C**.
F. Multiply **D** times **E**.
G. Move decimal two places left in data given in line **B**.
H. Local common carrier rate per pound.
I. Air or ocean freight to Detroit or Chicago (if part is purchased foreign).

Section 2

Materials cost.

A. Current price paid by Purchasing Dept.
B. Actual freight paid.
C. **A** plus **B**.
D. Information given in Section **1A**.
E. Section 2, **C** times **D**.
F. Move decimal two places left in data in line **2E**.
G. Given in line **1F**.
H. Subtract **2G** from **2F**; post result in box under unit in make indicator

Section 3

Labor and burden.

The rates are supplied by the Cost Dept. for the different processing departments. The costs are in dollars per 100 minutes; the minutes per 100 pieces are given in the routing book, as furnished by the Standards Dept.

A. To find the labor and burden per unit, multiply the **L** and **B** rate, times the minutes per 100 pieces for each department. This gives the cost per 100 pieces. Move decimal to convert to unit cost.
B. If the parts need plating, etc., by some outside vendor, post unit cost here.
C. Add line **2H** plus **3A** plus **3B**. Post result in box under unit cost of make indicator. If any operations on purchased parts need to be done in our plant, the costs are figured the same as the make parts and entered under the purchase indicator.

Section 4

Fixed costs. These are the setup costs of a job.

A. Multiply setup man's wages per hour, times the number of hours that it takes to set up job. Enter this under lot column in the make indicator.
B. Average cost of each purchase order written.
C. Total the fixed costs in each department, both make and purchase indicator.

PURCHASE MAKE COST COMPARISON

PART NO. 21306
PART NAME Rear Retainer

MACHINE CODE 123-20 VENDOR X - Y - Z Co. RM CODE 610040 DATE 9/6

Wt. RM/100 pcs.	5.64	Value Scrap/lb.	.25	Weight/Unit	.0237
Wt. Parts/100 pcs. −	2.37	Weight Scrap/Unit ×	.03267	Freight Rate ×	$1.30 CWT
Wt. Scrap/100 pcs.	3.27	Scrap Credit/Unit	.00816	Freight/Unit (Foreign)	

Variable Mfg. Cost	Make Indicator			Purchase Indicator			Indicator		
	Data	Unit	Lot	Data	Unit	Lot	Data	Unit	Lot
MATERIAL COST									
Price RM/lb. $ .50									
Freight RM/lb. + added in price									
Total Cost/lb. .50									
RM Wt./100 pcs. × 5.64									
RM Cost/100 pcs. $2.820									
RM Cost/Unit .02820									
Scrap Credit/Unit − .00816									
Net RM Cost/Unit .02004		$.02004							
LABOR AND BURDEN RATE × MINS/C									
Dept. 9 $11.548 × 10.4		$.01200							
Dept. 10 4.893 × 12.0		.00587							
Dept. 11 ×									
Dept. 15 6.679 × 1.52		.00102			$.00102				
Outside Operations									
Total		.03893							

FIXED COSTS (RATE × HOURS)									
Set-up Costs									
Dept. 9 $4.70 × 4.0			$18.80						
Dept. 10 3.57 × 1.5			5.33						
Dept. 11 ×									
Dept. 15 4.20 × .20			.84			.84			
Cost of Purchase Order						22.08			
Total Fixed Costs			$24.94			$22.92			
VARIABLE PURCHASE COSTS									
Unit Purchase Price					$ .10				
Duty/Unit					-				
Foreign Frt./Unit					-				
Net Cost/Unit					$ .10102				
LOT QUANTITY									
Number of pcs. in lot (ELQ)	20,000			13,000					
Weight of Lot				308#					
Cost of Freight						$ 4.00			
Value of Lot			778.60			1313.26			
Total Cost of Lot			$803.54			1340.18			
PROFIT ADVANTAGE									
Unit Cost		.04017			.10309				
Tooling Cost — {Amortized over 100,000 parts.	$480.00 =	.00480		0 =	0				
Total Unit Cost		.04497			.10359				
Unit Cost Differential				+ .05862					
Production Rate				× 250					
Profit Advantage/hr.				+ $ 14.65					
Ideal Cost $.04240									

Fig. 2. Form for detailed purchase-or-make cost comparison.

Section 5

Variable purchase costs.

A. Purchase quote. Enter under unit column of purchase indicator.
B. If foreign purchase, add actual duty per unit.
C. If foreign purchase, add actual freight per unit.
D. Add lines **5A, 5B, 5C** plus any cost from Section 3 that applies. Enter in box.

Section 6

Economical lot quantity. Formula

$$Q = \sqrt{\frac{2YS}{IC}}$$

Symbols: Y, yearly sales; S, procurement expense; I, interest; C, unit cost.

A. At Argus we use a simple manufacturing lot-size calculator. To use it, we need three factors: setup cost, unit cost, and monthly usage. This also is true for the purchasing of ELQ.
B. Multiply line **1G** times ELQ in line **6A**. Enter under purchase indicator under data.
C. Multiply weight of lot, line **6B** times local freight rate.
D. For the make indicator, multiply unit cost in line **3C** times ELQ; for the purchase indicator, multiply line **5D** times ELQ.
E. For the make cost, add line **4C** plus **6D**. Enter total in box under lot columns; for purchase part, add **4C** plus **6C** plus **6D**. Enter total in box under lot columns.

Section 7

Profit advantage.

A. Divide ELQ into total cost of lot (line **6E**). This gives unit cost for both purchase and make indicators.
B. Take total tooling cost, divided by expected life of product. Unit cost is added to whichever indicator it applies to, or possibly both.
C. Add line **7A** and **7B**, in both make and purchase indicators.
D. This is the difference in the make and purchase unit cost. If the purchase cost is greater, the differential is **plus.** If the make cost is greater, it is **minus.**
E. The expected number of pieces the machine will run in 1 hour.
F. Line **7D** times **7E** gives the profit advantage per hour, either plus or minus, as the sign indicates in line **7D**.
G. The ideal cost is the target price for the Manufacturing or Purchasing Depts. to try and match, to be competitive.

REASONS FOR MAKING VS. REASONS FOR BUYING. Cost studies are essential to deciding whether to make or buy, but other factors are involved, some of which are rather difficult to quantify. It follows that easy decisions are not possible. The following list of reasons for making and for buying given by Higgins (Harvard Business Review, vol. 33) should be helpful in evaluating all the relevant factors in a particular situation to arrive at a sound decision.

Reasons for Making:

1. Cost studies indicate it is cheaper for you to make than to buy.
2. Making fits your know-how, your equipment, and your tradition.
3. Idle capacity is available to absorb overhead.
4. What you are considering is unusual or complex; direct supervision is needed to assume control.
5. Making will facilitate your control of parts changes, inventories, and deliveries.
6. The part is hard to transport.
7. The design of the part or its processing is confidential.
8. You do not wish to depend on a single outside source of supply.

Reasons for Buying:

1. Cost studies indicate it is cheaper for you to buy than to make.
2. Space, equipment, time, and/or skill are not available for you to develop the necessary production operations.
3. Because of small volume or because of other capital needs, the investment in making is not attractive.
4. You wish someone else to face seasonal, cyclical, or risky market demands.
5. The need for special techniques or equipment makes buying more logical. Your supplier will help you produce a better engineered end-product.
6. You think it is best for your executives to concentrate on your specialty.
7. You want a check on your own operations.
8. Patents or customer-supplier relationships favor going outside.

Lease-or-Buy Decisions

PLANNING CAPITAL EQUIPMENT DECISIONS. Industry expansion and technological change contribute to the need for capital equipment replacement, up-dating, and addition, while the pressure for cost reduction frequently leads to decisions relative to capital replacement These conditions plus rising prices result in real difficulty in providing the capital necessary for **equipment** replacement.

In recent years increasing attention has been given to the lease as an alternative to purchasing. Leasing is considered by many to be an answer to some of these problems. In addition to the traditional leasing of land and buildings, **leasing arrangements** for factory equipment, office equipment, and automobiles have become widely available.

A survey of 266 industrial firms (Management Review, vol. 43) shows that 18% lease equipment while an additional 12% plan to lease. The items leased include machine tools, materials, handling equipment, and office equipment. The respondents mention (1) postponement of large initial outlay, (2) tax advantages, and (3) ease of keeping plant up-to-date as the principal **reasons for leasing** instead of purchasing.

THE SALE AND LEASE-BACK. The sale and lease-back can be looked upon as a variation of the lease-or-buy problem. The factors influencing the managerial choice and the pros and cons are similar and will be discussed here. Chiuminatto (NAA Bulletin, vol. 39) defines and illustrates the sale and lease-back as follows:

> Sale and lease-back of property is another newly popular device. This results in an immediate lump-sum increase in working capital represented by the proceeds of the sale at its current high market value less the tax, which frequently is at capital-gains rates on the profits realized. There is a substitution of a rental deduction for the otherwise available depreciation allowance.
>
> Suppose that a building purchased in 1920 for $40,000.00 is now worth $80,000.00 and is fully depreciated. The company needs $60,000 additional working capital and the building is its only means of obtaining it. No one will loan over 50 percent of the value or possible $40,000, and this is not enough for the needs of the business. Lease-back is therefore decided on, and the building is sold for $80,000. The profit realized is $80,000 because the structure is fully depreciated, but after a capital gains tax of 25 per cent, or $20,000, the net proceeds of $60,000 are available for the business. Further, there was no current tax deduction for depreciation, but under the new arrangement, there is a deduction for the rent paid to the purchaser. If the purchaser demands 6 per cent as a rental fee, that is only 3 per cent after tax saving is considered, and there is the further offset of earnings on the new capital.

FACTORS INFLUENCING SELECTION. The following factors should be considered in making a decision to own or lease:

1. Long-term stability of earnings.
2. Cost of alternatives.
3. Financing.
4. Adjustability to changing conditions.
5. Rate of return on investment.

The report of the subcommittee of the New York City Control of the Controllers Institute (Controller, vol. 21) provides the following summary and conclusions in its study of leasing vs. security financing:

The true nature of leasing is that it resembles ownership from debt sources, while the rental cost involves the obligation to amortize the landlord's investment and to yield an interest return at a rate somewhat higher than that for debt.

Leasing (borrowing property in kind) affords the advantage of enjoying its use without employing funds from invested capital sources (equity, preferred or debt).

At the termination of the lease, residual values such as land, the appreciated portion of which may have been created by the tenant's own operation, revert to the landlord who also enjoys the benefits of appreciation during inflationary periods. This is significant where the property is basic to the enterprise.

With leased property the risk of inability to pay rent is incurred with all the resulting potentialities of loss and penalties. In periods of economic stress, a tenant is less able to weather the storm than the owner who availed himself of the benefit of cash accumulations from depreciation accruals.

Under a lease, tax benefit is available for amortization of land and for accelerated depreciation. These benefits may be more than offset by the loss of residual values.

Where interest rates have dropped, or where property has lost its utility, a tenant's ability to adjust for these changes is less flexible than an owner's. The tenant's action is limited to dealing with the landlord or subletting if that right is available, while the owner can rent to others or sell in the open market.

Where existing debt provisions, or the company's existing financial condition make further debt financing difficult or impossible, a sale and lease-back may furnish an alternative source of working capital.

Where there has been major appreciation or depreciation in property values, a sale and leaseback may provide tax benefits in addition to working capital. These tax benefits must be carefully weighed against the present and prospective values of the property rights surrendered to achieve them.

It is difficult to reduce the problem of buy-versus-lease to a formula because of the wide variety of leasing plans offered by various equipment manufacturers and financial agencies which must be compared to the different purchase arrangements, including installment plans, by which the equipment may be bought. Further complicating the computations are a number of variable factors such as the different methods of depreciation which might be used if the asset were purchased, the future course of income tax rates, the rapidity of technological advances in the field, and the market value of the equipment at the termination of the lease. Treynor and Vancil (Machine Tool Leasing) have approached these problems by constructing tables for each of the various leasing programs and have reduced some of the variable factors to constants by making certain assumptions.

A number of writers on the subject, including Treynor and Vancil (Machine Tool Leasing), Anthony and Schwartz (Office Equipment: Buy or Rent?), and Keller (Management Accounting for Profit Control) stress a factor that appears to be omitted in some methods of computation, namely, the **desired earnings rate**

on the capital involved. This rate should be evaluated in the light of the risks associated with the investment.

LEASE-OR-BUY STUDIES. The problem of owning or leasing salesmen's automobiles is frequently encountered. The Controllership Foundation analysis shown in Fig. 3 does not consider a possible alternative of salesmen owning their own cars but concerns itself with an appraisal of own-or-lease company cars. In this case the advantage seems to be in favor of owning, by the small margin of some $9,000 for a six-year period. The factors used in developing this report (Controllership Foundation Report No. 6, Management Planning and Control) were:

1. Make and model were identical in both cases.
2. Because of variations in territorial mileage and/or road conditions, it was estimated that 16 company-owned automobiles would be traded every 2 years and the balance, or 55, would be traded every 3 years.
3. Operating costs of owned equipment were based on company-administered program with costs on an allowance basis. Past company experience and data secured from other sources, including other industry experience, formed the basis of setting these figures.
4. Leasing Company X agreed to replace cars every year or at a stated number of miles, whichever came first. This policy would reduce maintenance costs to a minimum and would practically eliminate consideration of battery and tire replacement.
5. Operating costs of leased equipment administered by the company under a standard allowance plan by a national service organization for this purpose.
6. A six-year period has been used in the study because of the variations in replacement cycles. The comparison can be considered to repeat itself every six years.
7. Under "Cost to Own," original purchase and all replacement costs have a 100% after-tax effect on cash. Tax credits on depreciation and losses from sales of used cars have a 52% after-tax effect on cash. Expenses have a 48% after-tax effect on cash.
8. Under "Cost to Lease," all transactions have a 48% after-tax effect on cash.
9. The total cash advantage of owning versus leasing was less than $9,000 for the six-year period and represented less than 2% on the investment, based on discounted cash flow method of analysis.

Advantages of Leasing. The advantages to the lessee of leasing have been summarized by Griesinger (Harvard Business Review, vol. 33) and include the following:

1. The lease provides cash-flow advantages for those companies that can use additional working capital for profitable alternative investment. This cash flow may be superior to other financing methods.
2. The total dollar-financing cost of the lease is high, but profits on the freed capital may far outweigh the additional expense.
3. Ownership of an asset may not necessarily be an advantage.
4. Leasing does not save taxes—it postpones them.
5. Some companies classified as good credit risks use leasing as a supplement to banking credit or to overcome presumed disadvantages in bank borrowing.
6. The depreciation provisions of the current tax law provide improved cash-flow advantage, but even so, leasing may be more beneficial than purchasing.

In addition, several writers have pointed out that leasing permits the lessee to avoid the risk of **technological obsolescence** and that leasing may accelerate the replacement of older, inefficient machines.

COST TO OWN			COST TO LEASE—COMPANY X	
Year	Item	Amount	Item	Amount
0	Purchase 71 cars @ $1,700 each	[$120,700]		
0	Title fee—71 cars @ $2 each	[68]		
0	License fee—71 cars @ $10 each	[341]		
1	Tax credit on added depreciation of $6,035	3,138	Cost to lease 71 cars	[$ 18,011]
1	Administrative cost—71 cars @ $22 each	[750]	Administrative cost—71 cars @ $16 each	[545]
1	Operating cost	[13,512]	Operating cost	[9,321]
1	Insurance	[3,203]	Insurance	[3,203]
2	License fee	[341]	Cost to lease 71 cars	[18,011]
2	Administrative cost	[750]	Administrative cost	[545]
2	Tax credit on added depreciation	3,138	Operating cost	[9,321]
2	Tax credit on loss of $600 per car for 16 cars	4,992	Insurance	[3,203]
2	Cost of replacing 16 cars @ $775 each	[12,400]		
2	Title fee—16 cars	[15]		
2	Operating cost	[13,512]		
2	Insurance	[3,203]		
3	License fee	[341]	Cost to lease 71 cars	[18,011]
3	Administrative cost	[750]	Administrative cost	[545]
3	Tax credit on added depreciation	3,138	Operating cost	[9,321]
3	Tax credit on loss of $745 per car for 55 cars	21,307	Insurance	[3,203]
3	Cost of replacing 55 cars @ $1,000 each	[55,000]		
3	Title fee—55 cars	[53]		
3	Operating cost	[13,512]		
3	Insurance	[3,203]		
4	License fee	[341]	Cost to lease 71 cars	[18,011]
4	Administrative cost	[750]	Administrative cost	[545]
4	Tax credit on added depreciation	3,138	Operating cost	[9,321]
4	Tax credit on loss of $600 per car for 16 cars	4,992	Insurance	[3,203]
4	Cost of replacing 16 cars @ $775 each	[12,400]		
4	Title fee—16 cars	[15]		
4	Operating cost	[13,512]		
4	Insurance	[3,203]		
5	License fee	[341]	Cost to lease 71 cars	[18,011]
5	Administrative cost	[750]	Administrative cost	[545]
5	Tax credit on added depreciation	3,138	Operating cost	[9,321]
5	Operating cost	[13,512]	Insurance	[3,203]
5	Insurance	[3,203]		
6	License fee	[341]	Cost to lease 71 cars	[18,011]
6	Administrative cost	[750]	Administrative cost	[545]
6	Tax credit on added depreciation	3,138	Operating cost	[9,321]
6	Tax credit on loss of $600 per car for 16 cars	4,992	Insurance	[3,203]
6	Present value of or cash received for 16 two-year-old cars @ $925 each	14,800		
6	Tax credit on loss of $745 per car for 55 cars	21,307		
6	Present value of or cash received for 55 three-year-old cars @ $70 each	38,500		
6	Operating cost	[13,512]		
6	Insurance	[3,203]		
	Six Year Total	[$177,768]		[$186,480]

Bracketed Figures—Charge to Cash.
Unbracketed Figures—Credit to Cash.

Fig. 3. After-tax cash effect of owning vs. leasing automobiles.

Disadvantages of Leasing. Kuenhold (NAA Bulletin, vol. 39) lists the disadvantages to the lessee of leasing as:

1. The cost of leasing may be too high. Rates are set to provide a manufacturer with his normal profit in addition to a reasonable return for the use of capital supplied.
2. There are certain prerogatives of ownership which must be surrendered when leasing. If a company desires to have complete freedom to relocate, alter, mortgage, or sell its equipment at any time, acquiring machinery which legally belongs to someone else may impose severe restrictions on the operation.
3. Tax uncertainties involved, . . . particularly if a purchase option is contemplated, provide certain pitfalls which could ultimately wipe out the anticipated gains to be achieved through leasing. If either the terms of the lease or the implied intentions of the parties is susceptible to interpretation as a conditional sales contract, the tax deductible feature of rental payments could be lost

To these disadvantages may be added Keller's point (Management Accounting for Profit Control) that "Purchase of equipment usually permits selection from a wider field of makes and types than is offered for lease."

POSITION OF THE LESSOR-SELLER. The preponderance of attention in the current literature on leasing is on the problems of the user of equipment who must choose between buying and leasing. This is not surprising in view of the fact that the users of equipment and buildings greatly outnumber the producers. The user of equipment has a problem in cost analysis, and the discussion in this section therefore is from the user's standpoint. Obviously the builder of equipment and of buildings also must weigh the advantages to him of leasing versus the various methods of selling, which is primarily a problem of distribution.

Economical Manufacturing Quantity

USE OF FORMULAS. Because of the many variables involved in the decision regarding economic-lot size, it becomes necessary to use mathematical formulas to arrive at a quantitative answer. Tabular and graphical methods have also been used. Whatever the method—formula, graph, table—it must be stressed that these are merely tools for measuring the effect of a number of variables such as interest, risk, depreciation, obsolescence, and storage. The heart of the problem is how to supply effective quantitative values for these variables.

Norton Formula. The Norton formula has been widely used in determining economic-lot size. It can be expressed as follows:

$$Q = \sqrt{\frac{S}{K}}$$

where $K = \left[\dfrac{(B + I)C + 2A(I - U/P)}{2NU}\right]$

Q = lot size.

S = total preparation cost per lot (dollars), including cost of preparing manufacturing orders, cost of setting up machines, and any other similar costs which are independent of the number of pieces in the lot.

P = pieces made per day.

U = pieces used per day.

N = days worked per year.

C = material, direct labor, and overhead per piece (dollars).

A = cost of storing one piece for one year (dollars).

B = taxes, insurance, etc., percentage per year on inventory.

I = desired return on capital, percentage per year.

Simplified Formula. A simplified version of this formula is expressed by Bowman and Fetter (Analysis for Production Management) as

$$Q = \sqrt{\frac{2RS}{I}}$$

The symbols used are:

R = units per year.
S = cost per setup.
I = cost per piece per year.

If we assigned value of 10,000 units for R, \$18 for S, and \$0.12 for I, the economic-lot size would be calculated as follows:

$$Q = \sqrt{\frac{2 \times 10{,}000 \times \$18}{\$0.12}} = \sqrt{3{,}000{,}000} = 1{,}000\sqrt{3} = 1{,}732 \text{ units}$$

Assumptions. As Clark and Ritchie (NAA Bulletin, vol. 34) observe, "Mathematically precise answers should not cloud the fact that they are no better than the assumptions used in arriving at them." They list the four principal assumptions in formulas of the type used here as follows:

1. Storage costs are truly variable, both as to space and time.
2. Manufacturing techniques remain the same no matter what the lot size throughout the range of lot sizes studied.
3. Costs are not reduced in larger lots because of an increase in operator skill.
4. Withdrawals from inventory are commonly assumed to be on a straight-line basis.

It is obvious that these assumptions may not always apply. Further, the use of the preceding formulas requires careful cost determinations which in some cases will be no easy task. Heiser (Budgeting—Principles and Practice) points out:

> . . . where many products are manufactured, it may not be practical to apply the formula separately to each one, particularly where the cost factors are subject to changes over a period of time. Consequently, determinations of this type may have to be (1) somewhat generalized, (2) made for families of products rather than individual products, and (3) constantly reviewed.

It should be noted that more complex models can be built to take into account any additional variables affecting economic-lot size. **Operations research** analysts have done extensive work in this area. Bowman and Fetter (Analysis for Production Management) suggest that:

> It is probably well to point out here that small differences in the problems call for small differences in the models. Likewise, large differences in the problems call for

(a) Lot size	500	1,000	2,000	5,000	10,000
(b) Number of setups, 10,000 ÷ (a)	20	10	5	2	1
(c) Maximum inventory	500	1,000	2,000	5,000	10,000
(d) Average inventory, ½ (c)	250	500	1,000	2,500	5,000
(e) Setup cost, \$18 (b)	\$360	\$180	\$ 90	\$ 36	\$ 18
(f) Carrying cost, \$0.12 (d)	\$ 30	\$ 60	\$120	\$300	\$600
(g) Total cost (e) + (f)	\$390	\$240	\$210	\$336	\$618

Fig. 4. Tabular analysis of economic-lot size.

large differences in the models. The important job is to build a model to fit the problem, not to memorize one that has already been built.

TABULAR AND GRAPHICAL PRESENTATION. Using certain basic information, the economic-lot size can be computed by setting up a table as Bowman and Fetter show in Fig. 4. The graph shown by Bowman and Fetter in Fig. 5 reflects the same information and has the advantage of showing clearly the behavior of costs relative to quantity manufacture.

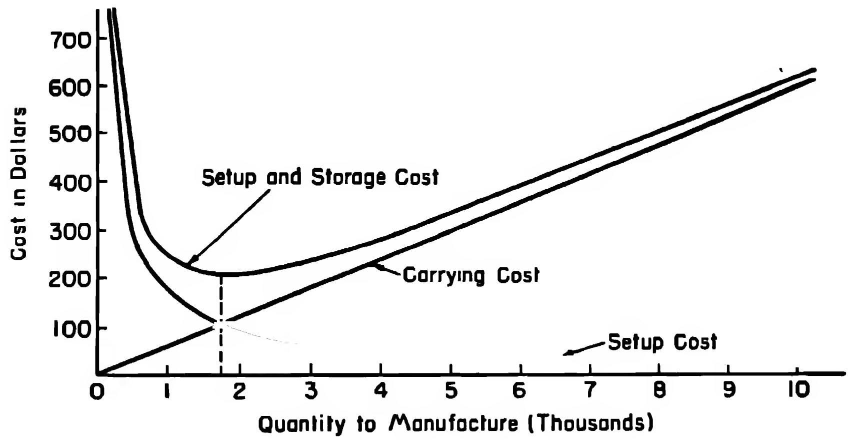


Fig. 5. Graphical presentation of economic-lot size to manufacture.

Product Pricing

ACCOUNTANT'S ROLE IN PRICING. The NAA Committee on Research (NAA Research Series No. 24, NAA Bulletin, vol. 34) states:

> Pricing is a profit-planning problem in which management searches out the alternatives and compares them one against another in order to choose the one which promises to be most advantageous In this process, the accountant has an important part to play in assisting management to evaluate the profit consequences of the various alternatives. This function is performed by determining anticipated cost to make and sell the company's products and the profit which can be expected at proposed selling prices.

The NAA Committee on Research states that its field study of 55 companies indicates that a good cost-accounting system is essential to good pricing. The Committee says it is evident that different functional groups must work together as a team in pricing a company's products and that the accountant is an important member of the team. The field study shows that usually the accounting department supplies the following types of information to be used in **pricing studies**:

1. Detailed costs of the individual products.
2. Anticipated profit, computed on a unit basis and compared with the standard objective established by company policy.
3. Historical reports of profits realized (usually the commodity profit and loss statements) to serve as a check on the effectiveness of pricing policy and practices.

The success or failure of an enterprise often hinges on the ability of its managers to set the right prices for goods and services. The accountant plays a strategic role in determining the prices set by a company. In completing his mission in the pricing process, the accountant should:

1. Recognize the limitations of traditional cost analyses when applied to pricing
2. Design the particular cost analysis suitable for the pricing situation.
3. Be aware of the nature of the demand side of the problem and the competitive environment as significant elements playing on price decisions.

RELATIONSHIP BETWEEN COST AND PRICE. Hartogensis (NAA Bulletin, vol. 39) expresses the **difficulties of pricing** in the statement that:

Pricing is a most complicated art but interesting because of its many ramifications and its vital importance. In this field, the difference between well-developed theories and practical, successful application is very wide. In few cases do mathematical formulas for setting prices prove satisfactory. Moreover, except in central security and commodity markets, the conditions and data which should provide a guide to sound pricing are vague or are not entirely ascertainable. It is pretty much a game of blindman's buff.

Greer (Harvard Business Review, vol. 30), after describing price making as "a difficult and delicate operation" requiring "a knowledge of economics, an understanding of markets, a familiarity with distribution techniques, and a grasp of the relevant cost facts," stresses that knowledge of the interrelations between cost and price and their effect on volume is basic to an understanding of prices. Greer goes on to say:

Costs do influence prices, but seldom control them (in the sense of exercising the final, exclusive dominance over their precise level and variation). Prices do influence costs but cannot regulate them (in the sense of forcing adjustments of specific amounts in any particular component). Both costs and prices influence the volume of goods that will be produced and distributed, and it may be volume that is affected when the cost-price relationship changes.

This can be put in still another way. Under conditions of economic stress requiring forced sale, cost is not relevant. Where goods are produced under conditions of reimbursed cost plus a fee or profit, cost is most significant. The practical day-to-day pricing problem lies somewhere in between these two extremes, and cost plays a varying role.

SIGNIFICANCE AND CHARACTERISTICS OF COST. The field study reported in NAA Research Series No. 24 (NAA Bulletin, vol. 34) indicates that cost is generally the starting point in pricing products. This research report recognizes that the concepts of cost most suitable for **pricing** purposes differ from the concepts used for **cost control** and **financial reporting**. The report sets forth the characteristics desired of costs used for pricing, as follows:

1. Cost should be stated in terms of product units.
2. Manufacturing and nonmanufacturing costs are equally important in pricing and both should be assigned to products, to obtain a complete unit cost to make and sell.
3. Current or anticipated costs are wanted for pricing because pricing decisions deal with sales to be made in the future. Historical costs and standard costs are significant only insofar as they provide a guide to current or future costs. When costs of materials, labor, facilities, and services change, costs previously recorded in the books may need to be restated in dollars having the same purchasing power as the dollars in which selling prices are being quoted.

It is well to observe that while characteristics of cost can be delineated, the use of cost for pricing involves a high order of relativity. Greer (Harvard Business Review, vol. 30) observes:

The "cost" of a product is not some single precisely calculable figure. Cost is a composite of numerous elements—some direct and some imputed, some fixed and some variable, some provable and some theoretical. No two cost-finding procedures are identical, and no one procedure will produce continuously identical results. Thus cost finding for pricing purposes is necessarily the assemblage of a variety of cost facts, which can be combined in a variety of ways to produce a variety of answers. The price maker can use them only as a guide and a point of reference. In constructing his price list, he will apply cost facts more or less conscientiously according to his philosophy and his circumstances.

PRICES BASED ON TOTAL UNIT COST. Howard (Marketing Management) observes that when executives responsible for pricing are asked how they set prices, the answer is, "They are based on costs." Dean (NAA 1949 Conference Proceedings) reports that several surveys indicate that the most common method of setting prices in many industries is to add a "fair" profit to cost. The costs used may be historical costs for the last available period, estimated costs, or standard costs. The "fair" profit used here is generally a **fixed percentage markup** which varies from firm to firm.

Cost and Pricing Forms. Illustrations of the kind of information furnished in connection with pricing based on total unit cost are shown in Figs. 6 and 7. Kelley (NAA Bulletin, vol. 38) presents Fig. 6 which is employed by the Adhesive and Coating Division of Minnesota Mining and Manufacturing Company and is used daily in pricing new products or repricing current products. In Fig. 7 Ottman (NAA Bulletin, vol. 31) illustrates full standard cost employed in pricing products. The prime overhead refers to **variable overhead**, and the secondary overhead is equivalent to **fixed overhead**. Ottman explains the **standard markup by products** as follows:

Market research and statistics staff, in collaboration with the sales staff, studies the products with the objective of establishing standard markup (profit percentages) to apply on manufactured product (standard factory cost exclusive of extra materials but inclusive of standard selling and administrative expense). These standard markup percentages are established by product grouping and are calculated to yield the company an adequate profit return from operations at normal capacity and with normal product (sales) mix.

It is well to add that the "Standard Pricing Base" (Fig. 7) serves as a guide for pricing and also as a basis for measuring variance between standard or planned profit and actual profit.

Conversion Cost Pricing. A variation of the approach just described is referred to as the conversion cost principle of pricing. This is described by Heath (NAA Bulletin, vol. 31) as a method whereby a specific rate to cover **profit** and **general selling and administrative expense** is applied to the total of direct labor and overhead. The justification for this method is that profits should be related to the services performed in the conversion of goods (frequently called "value added") rather than total cost.

Manufacturing Overhead and Total Unit Cost. It will be noted that manufacturing overhead, fixed and variable, is included in cost in the following illustra-

tions (Figs. 6 and 7). The amount of factory overhead applied to a product results from an assumption of a level of factory utilization or capacity and an application of cost to the product. The difficult task is in determining the so-called normal volume which is the basis for deriving unit overhead cost.

PRODUCT COST AND PRICING SHEET

Manufacturing Plant ______________ Product ______
Exp. Reference ______
Statement Date ______

Raw Materials ....
Labor ....
Burden ....

Subtotal ....

Refilling Waste ....

Total Bulk Cost ....

Container Size	Drum	5 Gallon	1 Gallon	Quart	Pint	Other
Bulk Cost						
Packaging Increment ...						
Factory Supply Waste ..						
Refilling Labor & Burden						
Total Factory Cost .						
Selling						
Administrative						
Laboratory						
Cash Discount						
Total Cost						
Suggested Selling Price ..						
Profit						
Percent Profit						

Price Approval: General Manager ________ General Sales Manager _______

Fig. 6. Form for computing product cost and price.

Keller (Management Accounting for Profit Control) attacks this task with a full awareness of the problems involved in determining values for such items as major maintenance details and depreciation (straight line versus declining balance, or variations of this latter method). He concludes that:

In general the dollars of factory expense which should be unitized in the costs to be used in setting sales prices will be those which should be incurred on the average in each year at normal volume with effective cost control. There are exceptions which arise when unusual conditions make it possible to recover more expense in sales prices. When sales levels require capacity operation, more overtime and other expenses are incurred than when production is at normal volume. If the demand is expected to continue for a long period, and there would be no adverse long-range effect on relations with customers, these higher expenses should be recovered in the sales prices.

STANDARD COST
ESTIMATED COST FOR XYZ Company **A**

ESTIMATE NO. --
SAMPLE NO. 27129

DESCRIPTION
#32 Handle Drawing #2B-960-A
Size: 4-3/4" x 1-1/8" x 3/4"

Made in 40 Cavity Mold

Compiled By	C.J.H. BB
Checked By	I.C.
Date Effective	9/12
Last Std. Cost	$7.95
Date of Last Cost	5/11
Product Inv. Class	002
Sales Class	362210
Piece Ident. Code	--
Estimate No.	--
Economical Lot Size	9600

WEIGHTS PER 100 pcs. GROSS 13.60# NET 12.40# PLANT ACCT. G.A.B. -- , PROD. ENGR.

Cost Center	OPERATIONS	Direct Labor & Material Minutes	Direct Labor & Material Rate	Direct Labor & Material Amount	Prime Overhead Minutes	Prime Overhead Rate	Prime Overhead Amount	Secondary Overhead Rate	Secondary Overhead Amount	Extra Material	Accumulated Totals
	Cpd. No. 989 @ 13/60#	-	.1589	2.16							
	Mixing No. 989 @ 13/60#	-	.0050	.07	-	.0065	.09	.0085	.12		
212	Mach. 13.60#	3.54	2.245	.08	-	200%	.16	189%	.15		
213	Cut Stock	1.00	2.163	.02	-	148%	.03	199%	.04		
218	Pull apart and weigh stock	15.60	1.866	.29	-	71%	.21	28%	.08		
221	Press - load and unload	15.60	2.517	.40	-	242%	.97	163%	.65		
221	Use of press	-	-	-	153.85	.275	.42	.222	.34		
811	First inspection (Schedule)	-	-	.11	-	-	.06	-	.09		
328	Pull apart and scrape	19.50	1.760	.34	-	55%	.19	52%	.18		
811	Second inspection (Schedule)	-	-	.04	-	-	.02	-	.03		
832	Packing labor and overhead (Sch.)	-	-	.08	-	-	.04	-	.10		
832	Packing mat'l and overhead (Sch.)	-	-	.04	-	-	-	-	-		
	TOTALS			3.63			2.19		1.78	-	7.60

Quotation No.	Quantity	Price	Unit	Equipment		% of Std. Pricing Base	
AA-40"2	50,000	10.75	C		Manufactured Product—Standard Factory Cost Before Damage	69.4	7.60
					Damage Allowance (% Std. Factory Cost—Mfd. Product)	5.4	.57
					Manufactured Product—Standard Factory Cost	74.8	8.17
					Extra Material Cost (Incl. - %, $ - Standard Damage)	-	-
					TOTAL STANDARD FACTORY COST	74.8	8.17
					Standard S & A Expense (9.4 % Mark-Up on Std. Fact. Cost Mfd. Product)	7.2	.76
					Std. Mark-Up (18% Mark-Up on Std. Fact. Cost—Mfd. Prod. & Std. S&A)	18.0	1.61
Price Set By E. S. B.		Date 9/15			STANDARD PRICING BASE	100.0	10.54

Fig. 7. Standard cost and pricing sheet.

In a recent report on pricing in the automobile industry, Cordtz (Wall Street *Journal, vol. 152) states that in the 1920's General Motors executives developed* a concept of **standard volume** as a basis for the allocation of costs which has been used by nearly all their companies ever since. The company builds **plant capacity** large enough to handle its forecast of its own share of the market over a long period, as well as the added volume of peak years in the same cycle. Costs are allocated and prices figured on the basis of the standard volume, which is a percentage of the plant capacity. Cordtz observes that:

> Standard volume really amounts to the number of cars over which all costs shall be spread for the purpose of estimated per-car costs and thus determining per-car prices. Because all costs—the value of unused plant and equipment as well as that being used—must be charged to standard volume, the per-car costs also include the cost of idle capacity.

Evaluation of Total Unit Cost Pricing. Recognizing the wide use of total unit cost pricing, Dean (NAA 1949 Conference Proceedings) has attempted to ascertain how it is justified by users of this method. He concludes that:

1. It provides a pricing ideal which may or may not be attained.
2. It permits a close approximation of the classical "just price," based on a "fair profit margin" after all costs are covered.
3. It is the logical way to maximize profits in the long run.
4. It is sometimes the safest course in pricing, especially for large firms where prices are pivotal and profits conspicuous.

Dean goes on to stress the inadequacies of total unit cost pricing as follows:

1. It ignores demand.
2. It fails to reflect competition adequately.
3. The costs usually employed convey a degree of precision which is not real because of the arbitrary nature of allocation of common costs.
4. It is based on a concept of cost that is frequently not relevant to the pricing decision. Pricing should be based on future costs, not current or past costs, and in many pricing decisions only incremental costs are relevant.

PRICING FOR RETURN ON CAPITAL EMPLOYED. This method is hardly a new one, for Dean (Managerial Economics) reports that it was employed by General Motors as far back as 1924. A recent report (Wall Street Journal, vol. 152) suggests that this method is employed generally in the automobile industry.

Establishing prices based on return from capital employed can be looked upon as a variant of the total unit cost method. Once a total unit cost is determined, the desired return on capital or assets employed is the key to developing the markup of cost to arrive at a sales price. The growing use of return on capital employed, as a basis for measurement and control of managerial performance in decentralized operations, would suggest that this method should be employed in developing markups.

Unit Sales Price Formula. Keller (Management Accounting for Profit Control) suggests the following formula for calculating unit sales prices using this method:

$$\text{Net unit price} = \frac{(C + RF)/V}{1 - RW}$$

The symbols indicate the following:

C = total of factory cost, selling, and administrative expense.
R = percentage return desired on capital employed.
F = fixed portions of capital employed, e.g., property, plant, and equipment.
W = variable capital employed, expressed as percentage of sales volume.
V = annual sales in units.

Keller illustrates the use of the formula as follows: Assuming that $C = \$100{,}000$, $R = 15\%$, $F = \$20{,}000$, $W = 30\%$, and $V = 200{,}000$, the **unit sales price** would be:

$$\frac{(\$100{,}000 + 0.15 \times \$20{,}000)/200{,}000}{1 - 0.15 \times 0.30} = \frac{0.515}{0.955} = 0.539267$$

The proof follows:

Sales 200,000 @ 0.539267	$107,853.40
Cost	100,000.00
Profit	$ 7,853.40
Capital Employed:	
Variable, 30% of $107,853.40	$ 32,356.02
Fixed	20,000.00
	$ 52,356.02
15% return on capital employed	$ 7,853.40

Steps in Pricing. This approach can be refined as suggested by Chiuminatto (NAA Bulletin, vol. 36). The determination of the percentage to be applied to unit cost to yield the price which provides the desired rate of return involves the availability of information on:

1. Products to be manufactured.
2. Normal rate of operation.
3. Standard volume.
4. Plant capacity.

Assuming that information is available regarding products and volume, a standard cost for 100,000 units of a given product could be developed as follows:

Raw materials		$125,000
Direct labor		200,000
Overhead:		
Fixed	$100,000	
Semi-variable	50,000	
Variable	25,000	175,000
Manufacturing cost		$500,000
Manufacturing cost per unit		$5
Selling, administrative, and financial expenses:		
Fixed		$ 85,000
Semi-variable		49,700
Variable		85,000
Commercial expenses		$219,700
Commercial cost per unit		$2.20

Determination of Fixed Assets Required. The next step involves determining the assets associated with the production and sale of 100,000 units of the product. If the value of fixed assets necessary to produce these units is calculated at $500,000, the following table of relationships can be worked out:

	Relationship	Normal Turnover Figure	Capital Requirements in Relation to: Sales	Factory Cost
Cash	Sales	20 times	.05	—
Accounts receivable	Sales	25 times	.04	—
Raw materials	Cost	12 times	—	.0833
Finished goods	Cost	12 times	—	.0833
Total working capital			.09	.1666
Fixed investment				1.0000
Total capital employed			.09	1.1666

The final factor required to determine a price which would return a desired 19% on investment can now be derived:

	Ratio to Sales	Ratio to Factory Cost
Working capital	.0900	.1666
Fixed investment		1.0000
Total investment	.0900	1 1666
*Add return of 19%	0171	2216
Add allowance for commercial cost	.2600	
Gross margin needed over and above factory cost	.2771	.2216

* (0.19 × 0.09 = 0.0171. 0.19 × 1.1666 = 0.2216)

The formula then becomes:

$$\frac{1 + 0\,2216}{1 - 0.2771} = 1.6900$$

In order to obtain a 19% return on investment, the selling price must be 1.69 times the cost of production, or $5.00 × 1.69 = $8.45.

The proof can be developed as follows:

Standard number of units		100,000
Desired selling price		$8.45
Resulting net sales		$845,000
Less: Standard cost of sales	$500.000	
Commercial cost ($2.20/$8.45 = 26% of sales)	219,700	719,700
Net profit		$125.300
Cash and receivables (0.09 of sales)		$ 76.050
Inventories (0.0986 of sales)		83,317
Fixed assets (0.5917 of sales)		500,000
		$659.367
19% return		$125,300

MARGINAL INCOME APPROACH TO PRICING. The use of total unit costing in **short-run pricing** has been criticized. NAA Research Series No. 24 (NAA Bulletin, vol. 34) states:

> Product costs based upon normal volume and normal mix of facilities do not provide a direct answer to questions which arise in short-range pricing because the point at issue is how costs will be changed by differing volumes and mixes.
>
> Thus, a unit product cost figure based upon normal volume ceases to be a helpful guide in pricing when the decision facing management calls for an answer to questions such as "How much will it cost to produce and sell an additional block of units?" and, "What will this specific order add to the company's over-all profits?"

To answer these questions and many others the NAA Committee on Research recommends the use of variable cost and marginal income as a basis for pricing decisions. A rather extended study of the application of the marginal income approach to pricing has been developed by Bergfeld, Earley, and Knobloch (Pricing for Profit and Growth). The position taken is that:

> The underlying principle of this P/V analysis (profit-volume analysis) is that the question, "Shall we raise or lower our prices?", is rephrased to, "What will happen, on balance, to our profits if we raise or lower particular prices?"
>
> The logic of our position becomes clear when it is recognized that all managerial planning is forward-looking. It should deal solely with anticipated and therefore estimated revenues, expenses, and capital outlays. All past outlays are historical and unchangeable—inescapable "sunk costs"—however they may be "costed" for financial accounting purposes, as for valuing inventories or distributing profit through time.

Basis for Acceptance or Rejection of Order. The method is illustrated by Bergfeld, Earley, and Knobloch in a situation involving the acceptance or rejection of an order under conditions of availability of manufacturing capacity. It is assumed that the company has been offered an order from "White" chain store for 10,000 motors at $100 each. The motor has a variable cost of $60 and will involve an outlay of $60,000 for setup, jigs, and dies. The latter cost is called a "Specific Programmed Cost," an expenditure to increase revenue or decrease cost in some specific sectors of an enterprise. At the same time the "Blue" chain wishes to place an order for 8,000 motors at $110 each; variable costs are estimated at $68 each, and Specific Programmed Costs at $50,000. Which order should the company accept? The calculations can be developed in the following way:

	White Order	Blue Order
1. Volume	10,000	8,000
2. Price	$100	$110
3. Added revenue, (1) × (2)	$1,000,000	$880,000
4. Unit variable cost	$ 60	$ 68
5. Added variable cost, (4) × (1)	$ 600,000	$544,000
6. Added P/V income, (3) − (5)	400,000	336,000
7. Specific programmed costs	60,000	50,000
8. Added profit-contribution, (6) − (7)	340,000	286,000
9. Unit P/V contribution, (6) ÷ (1)	$40.00	$42.00
10. P/V ratio, (6) ÷ (3)	40%	38%

The White contract is the more profitable because of its higher P/V ratio and larger volume resulting in the addition of $54,000 more in profit than the Blue order. In the graphic presentation of Fig. 8, Bergfeld, Earley, and Knobloch show the same case in the frequently employed **profit chart,** or P/V chart.

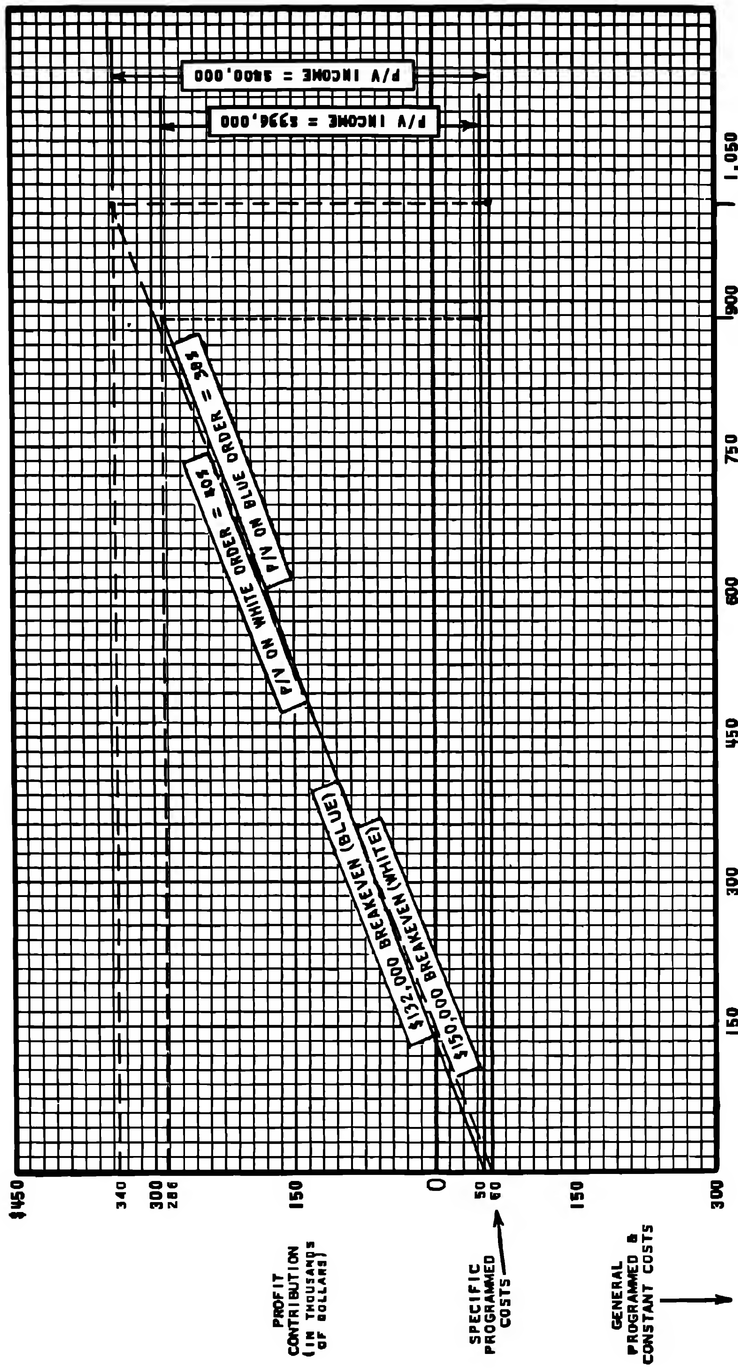


Fig. 8. Profit chart indicating more profitable order to accept.

Basis for Raising or Lowering Prices. The marginal approach is suggested by the same authors in decisions relative to raising or lowering prevailing prices. In the following illustration, two suggestions are submitted: one involving a 10% reduction in price to yield an increase in volume to 7,900 units from a current 6,600, the other urging an increase in price of 10% associated with a decrease in volume to 5,700 units. The details may be presented as follows:

	Present Sales	Increase Volume—Decrease Prices 10%	Decrease Volume—Increase Prices 10%
1. Volume	6,600	7,900	5,700
2. Price	$1,000	$ 900	$1,100
3. Gross revenue, (1) × (2)	$6,600,000	$7,110,000	$6,270,000
4. Unit variable cost	$ 500	$ 500	$ 500
5. Total variable cost, (4) × (1)	$3,300,000	$3,950,000	$2,850,000
6. P/V increase, (3) − (5)	3,300,000	3,160,000	3,420,000
*7. Constant and programmed costs	3,000,000	3,000,000	3,000,000
8. Profit contribution, (6) − (7)	300,000	160,000	420,000
9. Unit P/V ratio, (6) ÷ (1)	$500	$400	$600
10. P/V ratio, (6) ÷ (3)	50%	44.4%	54.5%

* Constant costs are fixed costs associated with this division's operations.

The analyses suggest that the greatest **profit improvement** would be yielded by raising the price, provided of course that careful market analysis indicates the likelihood of sale at the level suggested.

Utility of Marginal Approach. The marginal, or P/V, approach is suggested by Bergfeld, Earley, and Knobloch, as a general pricing tool for both long- and short-run situations. This would include questions on:

1. Raising or lowering prices.
2. Pricing new products.
3. Pricing different classes of customers.
4. Over-all pricing for long-run profit and growth.

Bergfeld, Earley, and Knobloch urge this extended use of the marginal approach in considering the argument that their incremental costing could produce a dangerous pattern of prices among products, while allocated costing ensures against this. They state that the issue of which costing system is better from these standpoints can be resolved into several questions:

> Will allocated or incremental costing better measure the costs your potential competitors would face if they were to turn to producing your products? Which more accurately reflects **future** as distinct from present cost levels and cost relationships? Will a policy of rather rigid and uniform pricing, such as full-costing brings about, be more or less discouraging to potential competitors than a policy that tends to make your prices more differentiated and more flexible through time?

They argue that their system is distinctly more effective because of two emerging characteristics of modern business: (1) the increasing prevalence of multi-product (and multi-process and multi-market) concerns, and (2) the dominant force of innovation in business. They conclude that "Full costing has been left behind by these new features of modern industry."

NAA Research Series No. 24 (NAA Bulletin, vol. 34) suggests restricting the application of the marginal approach to **short-run price situations** such as:

1. Evaluating proposals for change in selling price or terms of sale.
2. Segmenting the market to gain advantage of different layers of customer demand.
3. Selecting most profitable business when capacity is limited.
4. Determining price at which to refuse an order.

The NAA Committee on Research concludes this report on a word of caution:

Management needs to understand the nature of the costs and income margins which it uses in pricing in order to use the figures as guides in making the most of opportunities offered by market conditions. Executives are generally familiar with gross and net profit concepts because they have long been widely used. On the other hand, the breakdown of costs into fixed and variable categories and the use of marginal income rather than gross margin figures has been limited to a few companies until quite recently. For this reason, it is necessary for executives who make pricing decisions to learn to use the new cost concepts. The accountant, as an expert on costs, should be able to take the lead in this process of education.

COMBINED APPROACH TO PRICING. An approach to pricing, combining some elements of marginal and conversion costing, and in turn keying return on investment and market conditions, is demonstrated by Rushton (Controller, vol. 23). The requisites of a **desirable pricing practice** are listed by him as:

1. Master profit plan.
2. "Future" product costs specifically developed for pricing.
3. Target prices aimed at planned return on investment.
4. Competitive and companion product prices.
5. Market estimates, market attainment, and promotion.
6. Elasticity of demand: sales, cost, and price trends.
7. Customers' and competitors' reactions.
8. The price proposal.

This outline attempts to catalogue all the factors dealing with price which can be evaluated in an effective and expeditious way. It includes cost, competitive prices, market elasticity of demand, competitor and customer considerations, etc. Rushton presents the final price development summary in Fig. 9. The "Mark-on" referred to in the illustration is derived by relating the capital employed (fixed and current assets) to the desired rate of return of 20% before taxes.

Rushton explains the use of "direct cost" in Fig. 9 as follows:

In segregating income and expense between "direct cost" and "direct profit," the author does not advocate the "direct costing" method of accounting but does wish to say that the method has much to recommend it from an economic and statistical planning standpoint.

Total direct costs (sometimes referred to as variable, marginal, or product costs) are used instead of cost of goods sold because, first, knowledge is desired of all costs, not only manufacturing but also of administrative, selling, etc., which can be conveniently identified with selling a given amount of sales.

Secondly, we should know the direct profit, the excess of selling price over direct cost (or marginal profit, or contribution profit, as some call it) because it represents the out-and-out real profit of a company after breaking-even volume has been obtained. Why combine fixed costs and profit before tax under direct profit? Because there is little, if any, change in rate of direct profit or direct profit per unit regardless of the level of production—not considering cost, price, and capacity changes. At the unit-product level all that occurs is a switch between the two components, namely, fixed cost absorption and real profits. Therefore it is not enough to say that

PRICE DEVELOPMENT SUMMARY

Product Line: C **Production Center:** P **Product** #421

	Price	Sales Units	Sales $	Direct Profit $	Direct Profit %	Est. Net Profit (Before Tax) $	Est. Net Profit (Before Tax) %	% Product-Line Sales
Present	$3.10	300	$930	$510	55%	$210	23%	20%
Proposed	2.65	365	970	510	53	210	22	21
% Change	— 15%	+ 22%	+ 4%					

Unit Cost and Target Price

	Con-version	Total Direct
Present Cost	$0.75	$1.40
Future Cost	.65	1.25
Mark-on	100%	160%
Target Price	$0.65	$2.00
	$2.65	

Company	Competitive Prices	Trend	Mkt. Attainment	Promotion Rating
Own	$3.10	0	10%	B
A	2.55	--	16	A
B	2.50	--	17	C
C	1.90	0	3	D
Market Estimate				Units 3000
Attainment Goal			15%	450

Companion Products

P-422
P-598
P-621

Sales, Cost and Price Trends

Unit Sales	(1950-51	+ 15%
	(1952-53	—12%
Direct Cost	(1950-52	-0-
	(1953	— 11%
Price	1950-53	-0-

Customers' and Competitors' Reactions

Demand appears relatively elastic. Cos. "A" and "B" are not likely to reduce price further. Co. "C's" product not fully comparable in quality and potency.

ACTION:
Proposed price adopted

Effective:

Comments:

Fig. 9. Price development summary.

$250 will be earned in this instance to achieve 20% return on gross operating investment of $1,250, but rather that the $250 profit plus $250 fixed cost must be earned to achieve the 20%.

CONTROLLING PRICING DECISIONS. NAA Research Series No. 24 (NAA Bulletin, vol. 34) lists the following as methods currently in use for delegating responsibility for pricing decisions in the companies surveyed:

1. In the smaller companies and in a few larger companies where top executives are the principal owners, the president or some other top executive (for example, vice president in charge of sales, treasurer, general manager) makes all price decisions.
2. In the larger companies top management (for example, president, board of directors, a committee of top executives) establish price policies generally and approve price lists and quotations on important orders. The task of day-to-day decisions on prices is delegated to the sales department as long as these decisions are within the scope of established policies.
3. Some of the larger companies designate a committee of executives from various functional divisions (e.g., sales, manufacturing, accounting, general control) which formulates policies and approves price lists and prices on larger orders. Current price decisions are delegated to the sales department.
4. Decentralized companies frequently delegate the entire pricing function to the manager of the division.

It has been observed that some of the weaknesses in product pricing originate in **poor organization and procedure.** Oxenfeldt (Marketing Series No. 98, AMA) lists the following significant evidences of "soft-spots" in product pricing:

1. Failure to vest pricing responsibility in men who are suited by training, temperament, and interest for the task.
2. Failure to allocate a sufficient number of people or sufficient funds to the pricing function.
3. Failure to assure persons responsible for pricing of the assistance of others upon whom they must depend to do their job properly.
4. Failure to require regular and periodic review of prices to avoid perpetuation of mistaken decisions.

The complexity of the pricing task has led a number of writers to say that it is not a one-man activity. Rushton (Controller, vol. 23) expresses this view as follows:

[Pricing] needs the coordination of the cost accountant, industrial engineer, economist, statistician, and marketeer. Also, most agree that the job is, let us say, about one-third computation and two-thirds judgment. Nevertheless, the one-third computation is an essential aid to management in applying the two-thirds judgment.

Intracompany Transfer Accounting

PROBLEM OF ACCOUNTING FOR TRANSFERS. Traditionally, goods moving through a plant from one department to another or from one division to another are valued at **accumulated cost** to the time of transfer. This approach is derived from financial accounting, and its total entity view wherein the financial cost is a summation of all costs up to the point when the product is ready for sale.

It is only in recent years, with the trend toward decentralized organization (where each division or product group operates more or less as an autonomous unit), that the problem of interdivision or interproduct group-transfer pricing has become a problem. When each decentralized unit of the organization is deemed a **profit center,** evaluation of performance and the needs of decision making require a careful examination of intracompany pricing policy. The decentralized unit implies a delegation of authority to the manager of the unit, and the evaluation of his performance requires an adequate basis for pricing goods sold to the other units of the same company.

ADVANTAGES OF INTRACOMPANY PRICING. The advantages of the decentralized organization and the related intracompany transfer policies are noted by Breech (Planning the Future Strategy of Your Business, Bursk and Fenn, eds.) as follows:

Under the profit center system, revenue control of intracompany sales between various divisions of the same firm gives invaluable guidance in make-or-buy decisions, provides a check on supplier prices, and is a useful test of performance. Moreover, requiring our own producing divisions to sell competitively to the end-product divisions has contributed enormously to the improved profit position of Ford Motor Company.

Dean's observation in more general terms (Harvard Business Review, vol. 33) stresses the **advantages of decentralization** and related **competitive intracompany pricing** as follows:

The modern integrated, multi-product firm functions best if it is made into a sort of miniature of the competitive, free-enterprise system. The firm should be comprised of

independent operating units that act like economic entities, free to trade outside the company as well as inside. Each such entity or profit center will, in seeking to maximize its own profit, do what will maximize the profits of the entire company, just as individual firms in a private-enterprise society, by seeking their selfish advancement, generate the high productivity and well-being of a competitive economy.

DEFINITION OF TERMS. NAA Research Series No. 30, Accounting for Intra-Company Transfers, suggests the following definitions:

The term "interunit transfer" [intracompany transfer] is used to include any movement of products between divisions, plants, or other organizational units of a single company or between separately incorporated companies under common control. Products transferred may include materials and partly finished goods to be used in subsequent manufacturing processes and finished goods transferred for use or for resale. Services rendered for another unit are also included. Transactions of the type described above are, in practice, sometimes called transfers and sometimes called sales. The unit value at which goods or services are transferred is called the transfer price.

CRITERIA FOR DEVELOPING TRANSFER PRICES. It may be well to look at some suggested criteria before the specific methods employed in pricing transfers are examined. Stone (Accounting Review, vol. 31) suggests that:

An intracompany pricing method must meet several requirements that reach into the very heart of the decentralized operation. These requirements must be satisfied if the organization is to achieve the management efficiency that is its potential. First in importance is that the intracompany pricing method must arrive at a competitive price. This is basic to the entire structure of decentralization. Profits are the yardstick for the measurement of managerial ability. If intracompany prices are not natural, that is to say, competitive, this important means of evaluating management is lost. . . .

Top management must use divisional income statements in arriving at policy decisions concerning the profitability of divisional ventures. The decision to make or to subcontract various component parts of the company's end product will certainly be greatly influenced by the apparent profit or loss of a division. It is even possible that the decision to continue or to terminate operations of a division may depend on the same profit or loss showing. Intracompany pricing may well play a major part in showing a profit or a loss for a particular division. Unless top management is to ignore intracompany statements and go back to rule of thumb decisions in these matters, the intracompany pricing system must be realistic.

An examination of **company policies governing interunit transfers,** as reported in NAA Research Series No. 30, Accounting for Intra-Company Transfers, reveals the following:

1. Internal procurement is expected where the company's products and services are superior or equal in design, quality, performance, and price and when acceptable delivery schedules can be met. As long as these conditions are met, the receiving unit suffers no loss, and the supplier unit's profit accrues to the company. Often the receiving division gains advantages such as better control over quality, assurance of continued supply, and prompt delivery.

If a receiving unit finds that internal sources of supply are not competitive, policy calls for one of the following actions:

(a) It may purchase from an outside supplier after it has made a reasonable effort to bring the internal supplier unit's quotations and terms into line with those available outside.

(b) It is free to purchase outside but must be prepared to justify its decision. Central executives usually review such actions and have an opportunity to take action where needed.

Normally, the right to buy outside is seldom used because the advantages of integration make interunit transfers preferable for both supplying and receiving units. However, companies interviewed stated that the policy had sometimes been instrumental in bringing to light the presence of excessive costs due to obsolete or poorly located facilities, inefficient management, lack of volume, or other causes. However, in some cases it is customary to split purchases between internal and external suppliers because internal capacity is inadequate or because management wishes to have alternative sources available.

2. Transfer prices are expected to be competitive, but internal procurement is required or necessary because no satisfactory outside source is available. Where competitive market prices are not profitable to the supplier unit, central executive and staff facilities are utilized to formulate and put into effect a plan for improvement.

Interunit transfer policies applying to different products often vary according to the nature of the product and conditions under which it is manufactured and sold.

TRANSFER PRICING METHODS. The methods employed in industry can be broadly classified as follows:

1. Prices based on cost or variants of cost (budgeted cost plus profit, cost plus base-period profit, cost plus a fixed percentage, standard cost, etc.).
2. Market prices.
3. Bargained or negotiated prices.

COST PRICING BASES. Since there are many significant variants of the cost approach to pricing, each will be dealt with separately.

Actual Manufacturing Cost. This is by far the simplest method and is identical with the traditional method of valuation for inventory purposes. While of little worth for the purposes of evaluating performance of decentralized units or making decisions based on profitability of such units, it is used where the responsibility for profit performance is centralized.

Standard Cost. The criticisms indicated for transfer at actual manufacturing cost also apply to standard costs. It may be well to note the treatment of cost variances in this connection as cited in NAA Research Series No. 30, Accounting for Intra-Company Transfers:

> Where transfers are costed at standard cost, variances from standard cost are usually absorbed currently by the supplying division, but in a few cases the amount of variance applicable to transferred products is also transferred to the receiving unit.

Thus in one company cited in NAA Research Series No. 30, inventory is carried at identical standard cost by the issuing and receiving plants. The issuing plant treats variances from standard cost as a variance recovery, while the receiving plant treats them as a variance expense so that changes in costs are reflected in only the variance. NAA Research Series No. 30 explains the effect as follows:

> The effect is to charge the receiving division with the actual cost while limiting inventory charges to standard cost. Where inventories are costed at actual cost, the amount of variance applicable to transferred products is charged to inventory accounts of the receiving unit. Ordinarily, individual transfer shipments are priced at standard cost. The total charge at standard cost is then adjusted to actual cost periodically by applying variance ratios developed for broad product groups. Some companies using direct costing price individual transfers at standard direct cost and then include fixed period expenses of the supplier unit with variances in adjusting total transfer charges to actual manufacturing cost. Where standard costs are not in use, there are, of course, no variances to transfer.

Full Cost. Some companies include noninventoried expenses such as research, distribution, administration, etc. It is reported that, "in these companies, division

managers are responsible for profits on outside sales but supplying divisions are not permitted to make a profit on goods transferred to other divisions of the company." NAA Research Series No. 30 cites the following case:

In this company goods produced for other divisions were formerly transferred at inventoriable cost. In each supplier division, noninventoried costs applicable to transferred goods were absorbed by gross margin from outside sales. Supplier divisions sometimes showed a loss when a large portion of their capacity was devoted to production for interunit transfer. To overcome the divisions managers' reluctance to produce goods for other divisions, the transfer pricing plan was changed by adding to inventoriable cost a markup calculated to cover the applicable portion of noninventoried divisional overhead. Under this plan, the divisions recover full cost of transferred goods and benefit from the increased volume.

Full Cost Plus. Frequently a markup is added to manufacturing cost and noninventoried costs. While this method has a number of variants, it is of the nature of an **arbitrary price** set by a central management. Appraising industry practice in this connection, NAA Research Series No. 30 reports that the purpose of this pricing is to establish **interunit trading prices** at actual cost plus an allowance for a profit, which is determined as a specified rate of return on the capital employed. The **standard transfer price** for individual shipments consists of the following elements:

1. Standard direct cost formulated from raw materials purchase prices, direct labor rates, and variable overhead expense budgets.
2. Standard period expense, established by the annual period expense budgets The share of period expense applicable to the particular product is determined by distribution methods used in the individual plant. Standard period expense per unit of product is based upon a forecasted volume supplied by the receiving plant.
3. General administrative expenses at the rate of $x\%$ of capital employed, unitized at forecast volume.
4. Profit at the rate of $x\%$ of capital employed, unitized at forecast volume.

NAA Research Series No. 30, Accounting for Intra-Company Transfers, observes that:

For some products, no outside market exists, and there is no way to approximate a reliable competitive price. These circumstances are most common where all companies in the industry are fully integrated and each produces certain materials or components solely for its own consumption. In pricing such products, one company explained that its interunit transfer prices are designed "to strike a balance between a fair return to the supplying plant and encouragement to interplant business by conservative pricing."

Cost-plus pricing is also employed to reduce the amount of time devoted to interunit price negotiation when the items to be priced are comparatively minor in value. In these cases, methods of cost determination and rates of procedure are negotiated in order that future pricing may proceed routinely. This procedure is viewed as a form of competitive pricing by most companies. However, a few companies turned to cost-plus pricing when attempts to negotiate competitive prices resulted in time-consuming disputes among divisional managers.

Keller (Management Accounting for Profit Control) describes a type of full cost-plus method called the **budgeted cost-plus profit method**, as follows: "One method used to set intracompany prices for products which the producing unit does not sell to outside customers is to use the budgeted cost plus a specified return on the capital employed."

A simplified version of a cost-plus approach is suggested by Seed (NAA Bulletin, vol. 36) as the **standard cost plus a fixed percentage.** In describing the choice of this method he states:

The first thing we did was to assign each product to a single division responsible for its creation, manufacturing and distribution. We called this division the "primary point of manufacturing." After this assignment had been made and after selling prices and standard costs had been established for this primary point, we agreed that any manufacturing done for the primary point division would be considered subcontracting. The primary point division is billed at standard cost plus 10%.

MARKET PRICES. The market price method has many adherents. It is described in NAA Research Series No. 30, Accounting for Intra-Company Transfers, as follows:

A competitive market implies the existence of buyers and sellers, each acting in his own interest to establish prices at which goods are exchanged to mutual benefit. Such a market provides an incentive to efficient production because excessive costs cannot be passed on to buyers. By pricing interunit transfers at competitive market prices, this incentive can be introduced into internal operations which would otherwise be largely insulated from external competitive pressures. In addition, competitive market prices provide reliable measures of divisional income because these prices are established independently rather than by individuals who have an interest in the results.

The following examples (NAA Research Series No. 30) illustrate the fact that interunit pricing methods are influenced by characteristics of the commodity and the industry:

1. A pricing agreement setting out principles and procedures to be followed is negotiated between supplying and receiving divisions. Interunit transfers are then priced in accordance with the agreement. Companies interviewed apply this procedure where fluctuating market prices require frequent changes in transfer prices and where numerous items of small unit value are transferred.
2. Where transfers are nonrepetitive and the amount involved is substantial, prices are negotiated for each transaction just as they would be in dealing with outside suppliers.
3. Where periodic model or style changes are made in end products, prices of components are negotiated when new model specifications become available and remain in force for the life of the model or style. Plans for a new model often include a series of deadline dates by which interunit transfer prices must be established.
4. Standard items are often transferred at the supplier division's list prices. Little negotiation is necessary because uniform prices are usually quoted by all suppliers. When a lower price is quoted by an outside supplier, the buying division negotiates to obtain the same price internally if possible.

BARGAINED OR NEGOTIATED PRICE. A refinement on market price, consistent with the view that each decentralized unit is considered an independent unit and arrives at the **competitive price** by negotiation or bargaining, is described by Dean (Harvard Business Review, vol. 33). Dean describes the necessary condition for profit-center control as the freedom of division managers to negotiate competitive prices in arm's length bargaining and to go outside the company if the prices paid by or to other division managers are not agreeable to them. Dean points out that a division's profits and executive bonuses can be greatly affected by even small differences in the unit prices of transferred products. He holds that the identification of the selfish interests of the division manager and

the interests of the company as a whole can be maintained by intracompany pricing under the following simple principles:

1. Prices of all transfers in and out of a profit center should be determined by negotiation between buyers and sellers.
2. Negotiators should have access to full data on alternative sources and markets and to public and private information about market prices.
3. Buyers and sellers should be completely free to deal outside the company.

Dean comments that:

The practical benefits of sound transfer pricing for profit-center control are not always obvious. Many companies—especially if they are decentralized—seem to get along fine without it, never knowing what they are missing. This is because decentralization "digs gold with a pick-ax." In the flush of gratification for this great improvement over old authoritarian ways, management may neglect the tools to get the most out of it.

In a big company there is danger that interest in making profits will be diluted as a result of managerial specialization and the separation of operation from ownership. The parochial ambitions of operating managers need to be held in check; performance should be judged in terms of alibi-proof, objectively measured profits. When transfer prices are economically correct and profit centers are properly established, top management can delegate and still have peace of mind because the division manager's targets and incentives will be so set up that his interests are identical to those of top management.

ADMINISTERING INTRACOMPANY PRICES. The administration of intracompany prices can be viewed as centering on co-ordinations as well as settling "family disagreements" on prices. The sampling of industry practice reported in NAA Research Series No. 30 indicates that **central executives** usually administer interunit transfer policies, since they have the authority to co-ordinate all aspects of a company's operations and to resolve conflicts of interests which cannot be settled at the divisional level. After transfer policies have been established, the principal administrative problems usually center around the following topics:

1. Establishing a transfer price when the divisions concerned have been unable to agree. Emphasis is usually placed upon the point that pricing is a function which qualified divisional general managers should be competent to perform successfully. For this reason, it is expected that interunit pricing questions will be settled at the divisional level and only exceptional cases involving interests of the entire company are to be brought before central executives.

2. Reviewing current divisional actions from the standpoint of broad company interests. Typical problems which may arise are:
   (a) Keeping the divisions from pricing their products too high when it would be preferable to pass cost reductions on to outside customers in the form of lower prices or better quality.
   (b) Seeing that available facilities are used most advantageously. For example, it may be desirable to operate one plant at a loss when shut-down would mean loss of profits or failure to recover fixed overhead at another stage in an integrated series of processes.
   (c) Controlling divisional requests to set up facilities to make components and other items which can be procured elsewhere in the company. Control over such requests is usually maintained through the capital expenditures budget which requires approval by top management. By such centralized control, uneconomic duplication of facilities is avoided.

3. Providing staff assistance. Centralized staff departments are usually available to assist divisional management. For example, in one company a central financial

analysis department assembles information such as estimated suppliers' costs, and in another company a raw materials purchasing staff studies markets and price trends for the company's raw materials. Where a division is unprofitable, the central engineering staff may be called on to study the division's production methods and equipment.

The problems of the large company are more complex. Here the needs of each division selling to another division within the company on a competitive basis are equivalent to those of a division selling outside the company. Hauser (NAA Bulletin, vol. 37) suggests organizing for the sales function, the pricing and price analysis function, the cost estimating function, and a "control function devoted to processing of information through the various and sundry activities within the vending plant, thus assuring that service information essential to the customer flows directly through the sales department."

OPPORTUNITY TO PURCHASE OUTSIDE. Keller (Management Accounting for Profit Control) makes this important observation on the matter of **captive customers** in intraunit transfers:

> Intracompany pricing problems . . . arise in large part because the buying units are captive customers of the selling units. It is unlikely that a seller will give as much price consideration to a customer that he cannot lose as he will to one who can take his business elsewhere. For this reason many companies which have a policy of selling between units and of measuring profits of units couple it with a statement that the buying unit is permitted to purchase the products outside the company if intracompany prices are unsatisfactory to it.
>
> The opportunity to purchase outside the company places the buying unit on an equal footing with the selling unit in negotiating prices. The seller must meet competitive outside prices or lose the business. He does not have a captive customer. The policy of permitting purchases from outside firms cannot be a tongue-in-check policy if it is to be effective. Top management must encourage the practice with praise for the buyer who secured lower prices and censure for the company unit which lost the business.

Keller notes that the interests of a company unit and the over-all company may not coincide. For example, the lower costs of a unit's buying outside may not offset the diminished profits from the lower volume of the unit which lost the business. Keller suggests that if first consideration is given to over-all company profits by each manager and second consideration to the profits of his unit, each manager will be willing to compromise in the interest of the company. Keller concludes that:

> A policy of permitting products to be purchased from outside firms when another company unit cannot or will not meet the price, tends to reduce the number of problems related to intracompany pricing; it does not eliminate them.

Operations Research

NATURE OF OPERATIONS RESEARCH. There are many definitions of operations research, or **system analysis,** as it is sometimes called. Some are complex and some are rather simply stated. Sometimes it is described as the application of **mathematical methods** to business problems. The Committee on Operations Research of the National Research Council (Operations Research with Specific Reference to Non-Military Applications) defines operations research as ". . . the application of the scientific method to the study of the operations of large complex organizations or activities."

Johnson (The Application of Operations Research to Industry) defines operations research as:

The prediction and comparison of values, effectiveness, and costs of a set of proposed, specific courses of action involving man-machine systems. . . . based on a model of the action which has been analytically described by a logical and, when feasible, a mathematical methodology and which has had the values of basic action barometers determined either from a historical analysis of past action or from designed operations experiments. Most importantly, because all human and machine factors are meant to be included, an estimate of the uncertainty in the predicted outcome, and in the values, effectiveness, and costs of the proposed action is provided.

While the last definition may satisfy the sophisticated scientist, a more specific and possibly simpler definition is supplied by Pocock (AMA Special Report No. 13):

Operations research is a scientific methodology—analytical, experimental, quantitative—which, by assessing the over-all implications of various alternative courses of action in a management system, provides an improved basis for management decisions.

The significance of operations research to **decision making** in business is expressed by Trueblood (Journal of Accountancy, vol. 106) as follows:

By way of simplification, it might be said that in the past, management has been forced to isolate a single variable and to predict what would happen to operating results in terms of the various possible movements of that variable. The techniques of operations research permit the simultaneous manipulation of a number of variables.

To aid in a better understanding of what operations research is, Pocock (AMA Special Report No. 13) supplies five **characteristics** indicating that operations research:

1. Is concerned with the problems of business operations as a system.
2. Utilizes the scientific method, in that it is analytical, experimental, and quantitative.
3. Borrows scientific methodologies from all the various branches of science.
4. Almost always involves model building, which is fundamental to the scientific approach. There are many types of models—simulation, mathematical, physical.
5. Studies almost invariably involve predicting the effects of alternative courses of action.

Pocock observes further that operations research utilizes successful techniques employed in engineering, mathematics, statistics, physics, economics, and biology. Use of these various professional disciplines is so widespread that because of this there is a strong inclination for a person to see in operations research those elements with which he is familiar. Pocock states: "Operations research is a **new** discipline that borrows and integrates many of the old techniques to provide an improved analytical approach to management problem solutions."

OPERATIONS RESEARCH PROCESS. The basic process of operations research, according to Hurni (Operations Research, vol. 2), involves the following steps: (1) judgment phase, (2) research or synthesis phase, and (3) action phase.

This approach suggested by Hurni has been summarized by Schiff (Controller, vol. 24) as follows:

1. Judgment phase. This involves first a definition of the problem. The oft-used term "frame of reference" is injected here. This involves reviewing the basic assump-

tions relative to the situation—kind of situation (marketing, manufacturing, engineering), degree of boldness possible, range of calculated risks, and the characteristics of the situation (recurrence, isolated, interlocked with others, current knowledge about the situation, limits of time for decision to be reached) so as to apply the general process of analysis. Next is the investigation of the operational characteristics in the situation. Finally in this phase is the so-called feedback. Information acquired may well result in modifying what was originally within the frame of reference.

2. Research or synthesis phase. This part of the job involves the determination of methods and units of measurement, building the conceptual model, using mathematics to evaluate and understand the conceptual model, testing assumptions, making the model understood by others, and finally, classifying action alternatives. . . .

It may or may not seem apparent, but the general accounting system of a company is a conceptual model. It demonstrates the performance of a company's operation in terms of money. It can be used as a basis for deriving alternative decisions and permits limited prediction. It is limited by arbitrarily selected units of time and restricted to measurement in units of money. Operations research suggests the possibility of developing many other models for specific purposes and possibly for the whole business.

3. Action phase. Management is furnished with a description of the situation; alternatives of action; description of impact of each alternative action listing risks, opportunities, and impact on operational management; and assumptions underlying situation, scope, and limitations of each course of action.

Analytical Procedure. Spencer and Siegelman (Managerial Economics: Decision Making and Forward Planning), using a somewhat different approach, say that in operations research, decision theory, and economic analysis (including econometrics), the analytical procedure consists of the same four parts, as follows:

1. Arraying the alternative possible goals to be sought.
2. Defining the assumptions to be employed.
3. Determining and balancing the net advantages and disadvantages in selecting the optimum goal.
4. Modifying the selection by recognizing the institutional factors both inside and outside the firm that might make certain choices "impractical" or otherwise unpalatable, so that the final choice will fit in properly with the firm's over-all objectives.

Operations Research Model. The model appears to be the most widely used concept in operations research. Usually it is in the form of an equation. Brown (NAA Bulletin, vol. 39) makes the following observations on models:

> A model is a mental image of a real object or process, simplified and abstracted by suppression of irrelevant details and put into communicable form. A good model is a compromise between completeness and simplicity; it must be complete enough to provide useful information about the real situation and simple enough to be thought about fruitfully. Because it neglects certain details, it may apply to a number of different processes; the more abstract, the more situations it will fit and the less it will say about them, which is another reason for compromise. A model, then, is a description of a process. More, it is an explicit description.

Brown describes two valuable contributions from model making:

> First, the model allows us to see how the process would operate under different conditions, that is, to make projections and so to find the best methods of operation Second, study of the model inspires us to develop new concepts, that is, to invent new ideas which have a practical meaning in connection with the original process.

Simple Accounting Model. Sloat (NAA Bulletin, vol. 39) develops the following simple model to express mathematically the derivation of the balance of cash on hand at the end of any month as being the result of adding to the opening

cash balance the cash receipts and subtracting the cash disbursements during the month:

$$C_o + C_r - C_d = C_e$$

Sloat then observes:

All these mysterious symbols used by the mathematicians, when studied, turn out to be a form of shorthand which enables them to express highly complex relations in a very brief, straightforward, and precise manner. When these symbols are understood, they provide a much more satisfactory and a much more effective method of communication than does normal spoken language. They also lend themselves to manipulation by mathematical methods, with the result that extremely complex situations can be dealt with very satisfactorily.

Petersen (Illinois Business Review, vol. 13) emphasizes the importance of keeping the model simple because of difficulties in obtaining data and in making computations. He comments:

. . . the only models we have been able to make operational have been simple. In case after case the only use we have made of the more sophisticated models was to publish them in one of the journals where, presumably, they help make life interesting for graduate students.

The more elegant the model, the more refined and accurate must be the input detail. All too often complicated models call for inputs that are either unobtainable or can be obtained only approximately.

The use of high-speed computers has made more practicable the computation of the masses of data required in many operations research projects. One of the major factors in the rapid growth of operations research in the late 1950's was the development and increasingly widespread use of **electronic data processing.**

OPERATIONS RESEARCH ON MANAGEMENT PROBLEMS. Industry applications can be reviewed by reference to the particular methodology employed, i.e., linear programming, queuing theory, decision theory, game theory, etc., or by reference to the specific problem areas to which one or more techniques have been applied. For the purpose of this section it may be well to follow the latter approach, using the classification suggested by Churchman, Arkoff, and Arnoff (Introduction to Operations Research): (1) inventory processes, (2) allocation processes, (3) waiting-time processes, (4) replacement processes, (5) competitive processes, and (6) combined processes.

Inventory Processes. In operations research this means a process involving how much to order or produce and when to order. Thus these decisions involve balancing the costs of carrying inventory against order or setup costs, costs of shortages or delays, and costs associated with changing the level of purchasing or production. **Economic-order-quantity equations,** and **linear, dynamic, and quadratic programming** are among the tools used on these problems. Sloat (Controller, vol. 25) points out that the term "inventory" is used in a broad sense, and he refers to the example of an air line which used the inventory control approach in solving the problem of deciding how many stewardesses to train and when to train them.

Allocation Processes. Churchman, Ackoff, and Arnoff (Introduction to Operations Research) state that these processes arise when:

1. There are a number of activities to be performed and there are alternative ways of doing them.
2. Resources or facilities are not available for performing each activity in the most effective way.

The problem is to combine activities and resources in such a way as to maximize over-all effectiveness. Linear and other types of programming are tools commonly used in allocation problems. Examples of successful use of operations research on allocation problems include: distribution of freight cars among a number of terminals to meet demands; determining the location of bases and the best number of bases for an air line; decision as to the best product mix; scheduling production to make the maximum use of equipment; assignment of workers to specified tasks; determination of the locations and capacities of manufacturing plants or warehouses; and routings for the transportation of materials and finished products.

Waiting-Time Processes. These are often called **waiting line,** or **scheduling,** problems and arise from the great difficulty or impossibility of regulating the flow of work perfectly in accordance with the availability of facilities for doing the work. The problem is to minimize the costs of waiting time both of the people desiring the service and for the facilities. The tools available for solving these problems are specified by Churchman, Ackoff, and Arnoff (Introduction to Operations Research) as follows:

> **Queuing theory** is applicable to problems involving determination of the number of service facilities required and/or the timing or scheduling of arrivals. **Sequencing theory** is applicable to problems which involve determining the order in which units available for receiving service should be serviced. Finally, **line-balancing theory** is applicable to the problems which involve the grouping of work elements of the service activity into a sequence of servicing stations.

Van Voorhis (Operations Research, vol. 4) cites as examples of the application of **waiting-line** or **queuing theory** problems involving hospital appointment systems, aircraft at a landing field, cars at a toll booth, boats at landing docks, units on assembly lines, mechanics at a tool crib, and packages for truck delivery.

Replacement or Renewal Problems. These are generally of two types:

1. In the case of **deteriorating assets,** the problem is to time the replacement so as to minimize the sum of certain items, namely, the cost of the new equipment, the cost of maintaining the old equipment at a proper level of efficiency, and/or the cost of losing efficiency.
2. In the case of **items that fail,** such as light bulbs, the problem is to determine when and how to make individual or group replacements so as to minimize the sum of the cost of the equipment, the cost of replacing the units, and the losses arising from failure of the unit.

Since maintenance frequently involves the replacement of some components of a unit, **maintenance problems** may be regarded as a special class of replacement problem.

Thorough and systematic studies of equipment replacement processes predate the organized application of operations research to business. According to Churchman, Ackoff, and Arnoff (Introduction to Operations Research), the contributions of operations research have been in the direction of extending the application of the theory of replacement to phenomena not precisely treated and of attempts to extend the theory itself.

Competitive Processes. This is the type of situation in which the effectiveness of decision by one party is affected by the decision of another party. In general these situations may be classified into two groups:

1. **A game,** in which there are a specified number of players, rules stating all the possible permissible actions, a set of end states (for example, win, lose, and

draw), and the payoffs associated with each of these end states. The theory of games is applicable to this group, but it should be recognized that the mathematics of even simple games is very complex.

2. **A bidding situation**, which differs from a game in that: (a) the number of competitors usually is not known; (b) the number of possible plays may be unlimited; (c) the payoffs are estimated rather than known with certainty; and (d) the outcome (win or lose) usually can only be estimated.

Combined Processes. Usually actual problems involve more than one of the processes listed and discussed in the preceding five groups. Thus a **production control problem** would usually include some combination of inventory, allocation, and waiting-line processes. According to Churchman, Ackoff, and Arnoff (Introduction to Operations Research), "the usual procedure for handling combined processes consist of 'solving' them in sequence."

The six processes listed and described in the preceding text cover most but not all the operations-research problem situations faced in practice. Sloat (Controller, vol. 25) describes another group which he calls **information problems.** He suggests two types:

1. Problems which involve **proper selection of samples** to provide a basis for correct decisions. This includes analysis of markets, design of statistical quality-control programs, settling costs of interline shipments on railroads and air lines, and similar problems where it may be impractical to analyze all the data because of the cost involved.
2. Problems collectively referred to as **filing problems.** These situations require decisions regarding the retention and arrangement of information for maximum efficiency. Examples of such problems include designing the layout of a supermarket and assigning the best locations to the individual departments in department stores.

INVENTORY PROCESS ANALYSIS. It appears that more operations research has been directed toward inventory control than toward any other problem in industry. The problem of economic-lot size and its solution predates the introduction of operations research in this country. (See discussion in this section under Economical Manufacturing Quantity.) The contribution of operations research to the inventory problem in recent years involved attempts to establish procedures which could be used in situations where the demand had to be estimated.

A simplified illustration of the inventory process where the focus is on demand is suggested by Hurni (Planning, Managing, and Measuring the Business). A producer of a line of products found that the stocks consigned to his distributors were too large. The average inventory level of distributors was high, and large peaks of demand were followed by surprising periods of little demand. The distributors often argued that it was necessary to have the goods in order to sell or that the stock clerk knew what he was doing. But the volume of sales never quite seemed to justify the level of stocks. After various methods had been tried, such as attaining certain ratios of inventory to sales by reducing inventories across the board, and basing stock levels on average sales, Hurni states that the problem was finally resolved in the following manner:

A large sampling of orders was taken by individual product. These were classified first by percentage of total sample accounted for by various volumes of orders received in specified fixed periods of time. This is shown in Fig. 10, where the total sample is shown on the graduated vertical scale and the amount contributed by the aggregate value demands in fixed periods of time is shown on the horizontal scale.

In other words, we obtain a family of demand functions. You will note that for some products these demands are essentially straight lines of steep slope. Obviously these are products in which you have the goods to make the sale and in which it makes financial sense to have the goods on hand. At the other extremes, we also have demands which are almost straight lines, but these begin to approach horizontal. In this case, large stocks must be carried in order to get any appreciable amount of business, but it does not make financial sense to do so and probably not much marketing sense to carry any stock at all.

In the middle, there is a group of humped curves in which it appears that the optimum situation is near the hump, as the law of diminishing returns sets in at an increasing rate as the hump is passed. Just what point to pick is subject to mathematical analysis.

Although the information is shown graphically in Fig. 10, Hurni points out that it is possible to represent it in mathematical terms and that for some condi-

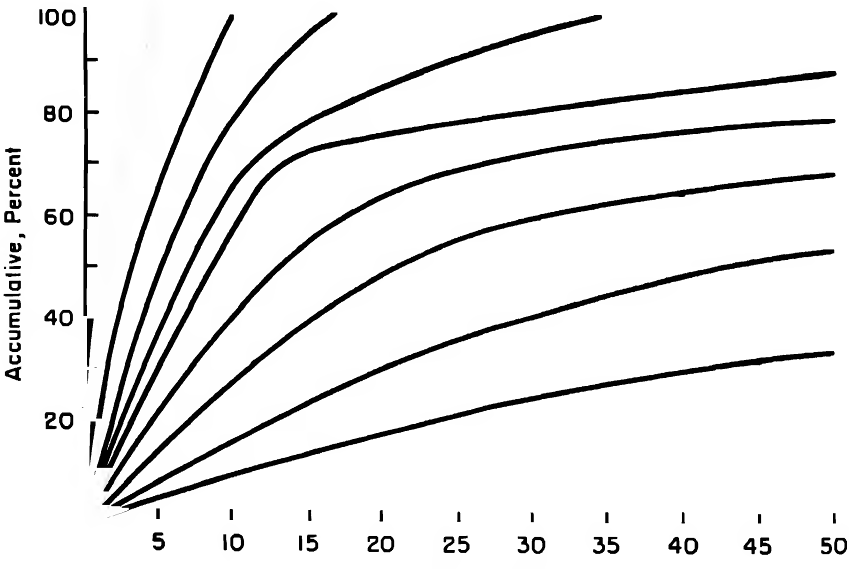


Fig. 10. Incoming orders to a warehouse.

tions the mathematical is far superior to the graphical representation. In Fig. 11 Hurni shows how the sampling must be expressed in another way, giving the frequency of recurrence of various demands in the fixed order periods. Fig. 11 also helps to explain why having the goods on hand is not necessarily the economical way to get business in all cases.

Hurni observes that mathematical representation becomes most helpful and convenient in the periodic measurement of performance. There is no assurance that the family of curves in Fig. 10, expressing the demand characteristics of certain products for a particular warehouse, will not change, even though the sample is a large one. The curves become a unit of measurement against which the actual occurrences at this warehouse must be measured for indication of change and need for new managerial decision.

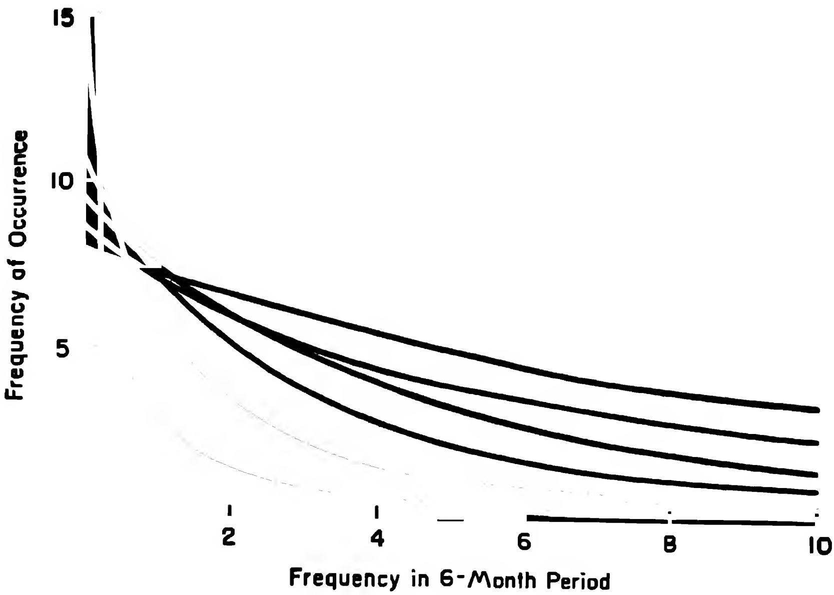


Fig. 11. Frequency of orders received, by size of order.

ALLOCATION PROCESS ANALYSIS. The tool most frequently associated with allocation process problems is called **mathematical or linear programming.** Alderson (Advanced Management, vol. 20) states:

> Linear programming sets out to identify the most favorable among feasible programs or ways of combining the possible activities or processes in a system of action. Starting with any given program, the method enables the analyst to find a more productive one if it exists, then a still better one, and so on

Knippenberg (AMA Special Report No. 13) describes the allocation problem of a manufacturer of a single class of packaged product sold directly to consumers. The products are made in four main plants in different states and shipped to 85 branches around the country which ship to retail outlets. One plant was old and operated at high cost, while the other three were newer, better equipped, and had lower labor rates and costs. These three plants could, by a small expansion of their capacities, absorb the load of the high-cost plant, but they would have to use higher-cost raw materials after their local supplies were exhausted. Knippenberg stated the four principal alternatives to be as follows:

1. Was the company presently using the four plants to best advantage? Without any fundamental changes in facilities, what were the best costs that could be expected of these plants by changes in planned output and distribution?
2. As a more drastic alternative, should the company move its high-cost plant operations to some other location, where lower costs might apply, but still retain four main plants to serve its total needs? This would entail some replanning of other plant usage and distribution. What could this situation save? What would the over-all investment be? And so on.
3. Should the company plan for a permanently reduced scale of operations in the high-cost plant and take whatever steps would be necessary to modernize it for this purpose? Would this be a logical course?

4. Should the company shut down its high-cost plant completely and fill all needs out of the other three plants—providing them with sufficient added capacity to handle the new production? What would costs and investments be in this case?

There was a wide range of freedom in working this problem, with the shipping costs to branches about the only cost factor that could not be controlled. It was necessary to determine the minimum obtainable cost for each alternative plan. It was decided to solve by linear programming. Knippenberg lists the following as the required steps:

1. Extremely precise data must be obtained on unit costs and buying capacities at each location.
2. With costs and capacities at hand, a grid or matrix of plant origins and branch destinations could be constructed. Each matrix would be a tabulation of the costs of making and shipping the product to all possible points from all possible sources.
3. Performing the linear programming would then consist of setting up mathematical relationships to take data in the matrix and compute a minimum-cost program of distribution, as well as to determine what the distribution pattern should be. The basic relations that would be satisfied in such a minimum cost program would be these:
   (a) Any one unit of capacity can be used to produce any one unit of requirements.
   (b) All costs are linear. That is, the cost of converting the unit of capacity into one unit of requirements is just one figure regardless of how many units are made. Twenty units will cost twice what 10 do, and so on. When costs are not linear, then only those portions that are linear can be considered.
   (c) All units produced and shipped must equal all units received, to balance the expressions.

It is worth noting that once the approach to the problem was delineated, it was necessary to supply adequate **cost information** for each of the four plants mentioned. The cost information included:

1. Plant capacities, and in particular, raw materials buying limits per year.
2. Manufacturing costs at varying volume.
3. Branch requirements.
4. Distribution costs from plant to branches.
5. Projection of alternative plant plans costs for present and for next five years.

Knippenberg points out that the task of servicing the cost information was the most time-consuming part of the study.

The first recommendation suggested the building of a new plant about 100 miles from the old, high-cost plant. It was observed that:

> This required a relocation move of 100 miles, but the company would receive a number of benefits directly as a result of the new site. These were apparent before we performed any program calculations. The savings, on the other hand, were less easy to foresee. It was here that linear programming was most useful, since it proved that in the over-all facilities decision there would also be a direct gain in operating costs.

This observation suggests something of significance to the cost accountant. The accountant has been of invaluable service to management by providing tools for cost analysis and cost control. His contribution can be extended when his tools are used in conjunction with those of operations research to provide a sounder basis for decision making where mere trial and error is too expensive a luxury. The emphasis on cost information indicated in the case just cited stresses the role of the cost accountant in operations research.

COMPETITIVE PROCESS ANALYSIS. Friedman (Operations Research, vol. 4) gives an illustration of simultaneous bidding on more than one contract, which may arise with the government. Each company must decide which contracts it should bid on and how much it should bid for each contract. Restrictions may be placed on each company's bidding, imposed either by the government or by the company itself. A few possible restrictions noted by Friedman are:

1. The company cannot bid for contracts such that the total cost estimates of the contracts bid on exceed a fixed amount.
2. The company cannot obtain more than a fixed number of contracts.
3. The company must have a certain confidence of obtaining at least a fixed number of contracts.
4. The company's total amount bid cannot exceed a fixed amount.

Different sets of bids are produced by each restriction or combination of restrictions. The particular restrictions in force determine the technique of solving the problem. Friedman assumes restriction (4) to illustrate the general idea underlying the solution of problems of bidding on simultaneous contracts:

This restriction may arise in several ways. The government may not wish any single company to obtain too much of the business and may place an upper limit, L, on the total amount each company may bid. Or perhaps due to financing difficulties or capacity limitations, the restriction may be self-imposed by the management. Thus, if x_i is the company's bid on the ith contract, we wish to maximize total expected profit subject to

$$x_1 + x_2 + \cdots + x_i - \cdots + x_n \leq L$$

Friedman uses each contract to obtain the **expected return curve.** As shown in Fig. 12, a table with three columns is constructed for each contract. The amount-bid column shows increases in even increments of reasonable size from the estimated cost of the contract to the point at which the profit expected becomes zero. The expected profit on the contract for the amount bid is listed in the second column. The change in the expected profit by the addition of an increment of bid is shown in the third column.

Application: Assume the situation in which we are interested in three contracts, and let us further assume that our upper bidding limit has been set at $440,000. The first step is to place our bids at the optimum point for each contract. In this case that would mean bids of $130,000 for Contract 1, $150,000 for Contract 2, and $180,000 for Contract 3. The sum of these bids is $460,000. This means we must reduce the sum of the bids by $20,000 Examination of the incremental changes in expected profit given in the third column enables us to determine which bids should be reduced so as to get within the allowed limit. We see that the first $5,000 reduction in bid should be made on Contract 2, since this reduces expected profits by only $100, while $5,000 reductions on Contracts 2 and 3 result in profit deductions of $300 and $400, respectively.

Proceeding in this manner, we eventually obtain the optimum set of bids permitted within the restriction. The optimum set of bids [for the table] are $125,000 for Contract 1, $140,000 for Contract 2, and $175,000 for Contract 3.

INDUSTRY USE OF OPERATIONS RESEARCH. A survey made by Arthur Andersen & Co. on the use of Operations Research in American industry, reported by Hertz to a special American Management Association conference (Controller, vol. 26), showed that in the 1950's operations research became recognized as a valuable tool in decision making by business management. The survey of 324 companies, or slightly more than 51% of the 631 responding, said they were using operations research techniques. Of the 307 companies not using them,

Contract 1			Contract 2			Contract 3		
Amount Bid	Expected Profit	Change in Expected Profit	Amount Bid	Expected Profit	Change in Expected Profit	Amount Bid	Expected Profit	Change in Expected Profit
$100,000	0		$100,000	0		$100,000	0	
105,000	$3,000	+$3,000	105,000	0		105,000	0	
110,000	5,500	+ 2,500	110,000	0		110,000	0	
115,000	7,500	+ 2,000	115,000	0		115,000	0	
120,000	9,000	+ 1,500	120,000	0		120,000	0	
125,000	9,900	+ 900	125,000	$2,000	+$2,000	125,000	0	
130,000	10,200	+ 300	130,000	3,700	+ 1,700	130,000	0	
135,000	9,900	− 300	135,000	5,100	+ 1,400	135,000	0	
140,000	9,000	− 900	140,000	6,100	+ 1,000	140,000	0	
145,000	7,500	− 1,500	145,000	6,700	+ 600	145,000	0	
150,000	5,500	− 2,000	150,000	6,800	+ 100	150,000	0	
155,000	3,100	− 2,400	155,000	6,400	− 400	155,000	$3,000	+$3,000
160,000	300	− 2,800	160,000	5,600	− 800	160,000	5,500	+ 2,500
165,000	0	− 300	165,000	4,400	− 1,200	165,000	7,500	+ 2,000
170,000	0		170,000	2,900	− 1,500	170,000	9,000	+ 1,500
175,000	0		175,000	1,100	− 1,800	175,000	10,000	+ 1,000
180,000	0		180,000	0	− 1,100	180,000	10,400	+ 400
185,000	0		185,000	0		185,000	10,200	− 200
190,000	0		190,000	0		190,000	9,400	− 800
195,000	0		195,000	0		195,000	8,000	− 1,400
200,000	0		200,000	0		200,000	6,000	− 2,000
205,000	0		205,000	0		205,000	3,500	− 2,500
210,000	0		210,000	0		210,000	500	− 3,000
215,000	0		215,000	0		215,000	0	

Fig. 12. Bids and profitability on three contracts.

144 said they were considering the adoption of operations research in the future. The fields that accounted for the largest percentage of users were chemical, electrical, and electronics manufacturing companies. The problems on which operations research was most commonly used were in the areas of production, sales and marketing, and inventory. A high percentage of the companies reported using operations research on long-range planning problems.

THE ACCOUNTANT AND OPERATIONS RESEARCH. It has been noted in the illustration of industry application of operations research that cost information is essential to effective analysis. While it is readily conceded that the kind of cost information needed by the operations research analyst is much different in most cases from that which the cost accountant traditionally develops, it should be stressed that the degree of competence developed by the cost accountant should be the determinant of his ability to work with the analyst. This does not suggest that the cost accountant with some advanced training in mathematics can be the operations research analyst. Rather it suggests recognizing operations research as a specialized field of endeavor which makes a significant contribution to business management in its field, as does cost accounting in its area. The suggestion addressed by Schiff (New York Certified Public Accountant, vol. 27) to the CPA could well apply to the cost accountant:

> It should be quite evident that O.R. studies complex issues and applies highly developed and refined tools of analysis. It is quite apparent that the professional accountant normally can hardly extend his professional knowledge to this field. Some of the very large firms have hired O.R. analysts and offer this service to their clients. The typical practitioner is hardly able to do so. Yet he cannot ignore progress. He must recognize those business problems, the solution of which depends on the effect of the interaction of many factors. He should recognize the possibility of effective analysis through the employment of a competent O.R. analyst and work with him in providing business management with a choice of alternatives which result from a careful evaluation of all the measurable elements. The CPA does not normally hesitate to urge the employment of an attorney where legal problems arise, nor does he hesitate to recommend the employment of an industrial engineer in connection with problems of layout, time-study, etc. The CPA would be remiss in his obligations to his client if he did not urge the employment of an O.R. analyst for the specific problem areas where such service is called for.

Operations research, by its nature, is a team activity drawing upon the training and experience of individuals in more than one discipline. The accountant, as the representative of the major agency for collecting and summarizing cost and operating statistics, should be a member of that team.

Hurni (Operations Research, vol. 2) comments:

> The answer lies not in knowing linear programming, or queuing theory, or decision theory, or game theory, or mathematics as such, but in defining the characteristics of a situation in such a manner that these and other tools may be validly and understandably used.

LIMITATIONS OF OPERATIONS RESEARCH. It should be recognized that operations research is limited to the analysis of tangible, measurable factors. Qualitative or intangible factors are often very important in making business decisions. The business executive will still make final decisions based on his experience and judgment after evaluating the findings of operations research and the assumptions upon which these findings were based.

As in the case of some other new techniques, many people in business do not understand operations research, and some are inclined to expect too much of it.

Odiorne (Journal of Industrial Engineering, vol. 8) also feels that some of its proponents have claimed too much for it. He writes:

> We must conclude that OR is simply another method which can be used profitably within the context of some special area of closed knowledge. This is a far cry from the exalted status which is claimed for it by some of its more opportunistic adherents

Magee (AMA Manufacturing Series No. 211) concludes that operations research "complements, rather than competes with, or supplants, other services available to the executive such as market research, accounting, and industrial engineering." Haskins & Sells (Operations Research) state:

> Operations research stands as a positive force of strong potential in the analysis of business problems. It provides better understanding, in itself a long-range benefit, and frequently points the way to worth-while immediate improvement. Operations research is taking its place as a useful tool to aid management in decision making

SECTION 2C

COST CONTROL, BUDGETS, AND REPORTS

CONTENTS

CONTENTS (*Continued*)

SECTION 20

COST CONTROL, BUDGETS, AND REPORTS

Importance of Cost Control

MANAGEMENT CONCERN. The material and human resources to satisfy human wants are not available in unlimited quantities to society as a whole or to individual economic units. Since resources are relatively scarce and limited, anyone involved in some way in the management of resources is necessarily concerned with the **effective utilization of the resources** available to him in discharging the economic functions for which he is responsible. The American Management Association (Special Report No. 4) stresses the importance of **cost control** as follows:

> Production costs—direct and indirect—can become a threat to competitive survival without constant vigilance on management's part. Regular, selective pruning is required to weed out unjustifiable expense, yet at the same time retain the occasional increase expected to produce long-term savings.

In any business, but especially in those in which prices are established competitively, costs must be controlled if profits are to be realized year after year.

There are many indications that American management in general is aware of the importance of cost control. The team of prominent British accountants who visited American companies to study the ways in which management used accounting services reported (Management Accounting, Anglo-American Council on Productivity): "'Cost consciousness' is the outstanding feature of the American industrialist." When Ernest R. Breech was made chairman of the board of directors of the Ford Motor Company in recognition of his contribution to the great improvement in that company's condition, he said that early in his career he had adopted the view that whether a company prospered or failed depended to a large extent on cost controls (Life, vol. 38).

OWNER INTEREST. Since owners are basically dependent upon the presence of profits for dividends, and since most owners make investments for long-run investment and not for speculation, the effectiveness of cost control techniques and actions affects their **return on investment** and the long-run safety of the principal contributed.

EFFECT ON EMPLOYEES. Workers have a general and specific interest in the effective utilization of resources by business firms. In a general sense they will benefit through the increase in the availability of consumers' goods at reasonable prices. In a specific and direct sense, they will benefit through continuous employment and increased compensation. **Labor cost control** does not mean reduction of wages but increasing productivity so that labor cost per unit is decreased, or at least not increased, as absolute wages increase. Jones (NAA

Bulletin, vol. 37) reports results mutually satisfactory to the company and its employees:

> Through the operation of our incentive plan . . . we have increased our machine efficiency by one-half. . . . Our production flow has been smoothed, resulting in a cheaper operation and at the same time satisfying a larger customer demand. A notable reduction in delays and downtime has been accomplished. Our operators take pride, even a proprietary pride, in their work and have substantially increased their earnings.

CREDITOR INVESTIGATION. According to Blocker and Weltmer (Cost Accounting) creditors of various kinds are concerned with, and often seek, information concerning the presence and effectiveness of cost control systems. They add: "It has become a policy of many banking institutions that no loans will be made to industrial firms unless such concerns have complete cost accounting systems which produce reports showing satisfactory trends."

INFLUENCE ON CUSTOMERS AND GENERAL PUBLIC. The level of costs incurred by a particular firm and by a particular industry affect the customers' **standard of living** through the prices paid to cover the costs. Firms or industries with excessive costs, and perhaps excessive prices, are potentially unstable and face decline or failure. Such declines and failures have a disruptive effect on the economy. On the other hand, St. Peter (NAA Bulletin, vol. 35) expresses the conviction that those business leaders who succeed in reducing operating costs are not only improving their own economic status, but they are also further expanding job opportunities and contributing substantially to a prosperous and stable economy.

DEFINITION AND RELATIONSHIPS OF CONCEPTS. Certain concepts are basic to any plan to achieve effective utilization of the productive resources of a firm. These concepts are **analysis, control, budgets** and **reports.** The first two concepts are discussed immediately below, while the last two are discussed later in this section.

Meaning of Analysis. The basic meaning of **analysis** (Webster's International Dictionary) is "the separation and examination of anything to distinguish its component parts and study their relationship to the whole."

In cost accounting, analysis involves the separation and examination of physical facts, or dollar cost data, to distinguish particular measurements in either physical units or type and magnitude of costs. The purpose of analysis is to obtain control over costs. Analysis aids in the discovery of defects in methods, physical facilities, man power, and organization.

Meaning of Control. Control is described in a few words by Lang–McFarland–Schiff (Cost Accounting) as "the guidance of the internal operations of all divisions of the business to produce the most satisfactory profits at the lowest cost." The Cost Concepts Committee of the American Accounting Association, as reported by Anthony (Accounting Review, vol. 32) concluded that the **control process** involves three aspects:

1. To communicate information about proposed plans.
2. To motivate people.
3. To report performance.

Bedford (NAA Bulletin, vol. 38) emphasizes the fact that control necessarily relates to the future.

The essential nature of control involves not so much the correcting of past mistakes as the directing of the current and future activities in such a manner as to assure the realization of management plans. In a sense, control becomes methods of motivating various members of a business organization to assure actions on their part which are to the benefit of the firm. Normally, such action will involve the carrying out of the adopted plans of management.

These statements indicate that control involves the making of decisions, based on relevant information, which lead to plans and actions that improve the utilization of the productive assets and services available to management.

How Control Is Accomplished

GENERAL CONTROL FACTORS. Most authorities agree that **planning** is the basis for control, **information** is the guide for control, and **action** is the essence of control. This applies to small firms as well as those of moderate or large size, but a more formal system must be developed to accomplish effective utilization of resources in moderate or large size firms. This point is emphasized by Hartogensis (NAA Bulletin, vol. 37) who says management control may be particularized as requiring:

1. A means of communicating policies and general objectives and the assumptions on which the general objectives are based
2. A means of reviewing and approving the proposed plans of subordinate levels of management to make sure of coordinated action toward the desired end
3. A means of measurement of results against the plan and the desired objectives, with provision for analysis of deviations from the plan.
4. A means of two-way communication for reporting variances from the plan and the reasons for such variances, in order to plan corrective action to be taken in such cases and to follow up to see that such action is taken and is effective

RESPONSIBILITY OF ACCOUNTING GROUPS. The results of operations must be expressed as human responsibilities, not as abstract concepts. Men rather than analyses or reports control operations. Workers, foremen, superintendents, and chief operating executives produce goods and spend money. They are the men with ability to select the most efficient manufacturing methods, to use time most productively, to make the best use of materials, to coordinate and integrate the enterprise in the most effective manner. To do their jobs well they need facts. Supplying the **factual basis** for control is a function of accounting.

It is essential that **account groups** be planned so that results by responsibilities flow directly from them. Confusion as to responsibility is very harmful to good control. Full cooperation between operating executives and accountants is essential in developing a proper balance between the accounting mechanisms and the control objectives.

Emch (Harvard Business Review, vol. 32) emphasizes the fact that organization and control are inseparable.

This, then, is the problem of control: to match the responsibilities of every key position with the management information necessary for the effective and efficient execution of those responsibilities. Control itself can be defined as the making of decisions and taking of actions required by the responsibilities of each position, i.e., the proper performance of each executive according to the requirements of his position.

The cost accounting system, cost analysis, and other techniques used to facilitate cost control must not only provide for performance evaluation by **centers of**

responsibility, but it should also promote alertness and stimulate initiative at all levels of operating personnel.

TECHNIQUES AVAILABLE TO ACHIEVE CONTROL. Prior to the development of large-scale operations, management was in a position to observe operations continuously. **Observation** was probably the original means of control. As the size and complexity of industrial organizations increased, observation became ineffective or impossible as a means of control. When the inadequacy of observation, by itself, was recognized, the techniques of formal control were developed.

There are various techniques available to achieve control. Some are **informal techniques** and require only the alert observation of physical conditions during daily operations. Others are more refined and formal, the result of careful accounting or statistical analyses, or engineering study.

Usually, none of these techniques stands alone as the only control device. Rather, **combined techniques** are used, often to complement each other, in groups appropriate to the cost control problem at hand.

SELECTION OF CONTROL DEVICES. In order to ensure that the control devices provided will be understood and used, many companies let those responsible for performance take an active part in developing the control techniques (see "Human Reactions to Standards and Controls" in this section).

NECESSITY FOR GRADUAL DEVELOPMENT. In the small plant, without adequate staff personnel, or the large plant with a multitude of operations, gradual development is the most feasible approach and in the long run probably the soundest approach. Keller (NAA Bulletin, vol. 35) states, for example:

> In tackling the problem, take one item or operation at a time, study it, establish basic data for measurement and comparison, and then use these data to provide management with specific ways and means for controlling and reducing the costs. Standards and budgets are the most effective tools for accomplishing this. However, the greatest mistake which could be made would be to attempt to set up a complete system of standard cost accounting and budgetary control and put it into operation throughout the plant as of one date. The area selected as a starting point would be one in which a major segment of the total cost of production is being incurred.

VISUAL OBSERVATION. Lang–McFarland–Schiff (Cost Accounting) distinguish two kinds of control, **control at the source** and **control through reports.** They indicate the important role visual observation still plays, while recognizing that it is not adequate by itself:

> Control at the source takes place at the operating level, usually on the basis of physical, on-the-spot observation by the foreman or other executive responsible for the performance of the men under him. Because of the size and complexity of modern business, control at the source is not always possible and even where it occurs it is supplemented by reports at different managerial levels where each level is held responsible for action at the next lower level.

Visual or physical methods of inspection and the visual alertness of productive workers or service workers, such as departmental salvage men, can provide timely clues within each work day to minimize losses due to faulty method or faulty materials. Davison (Controller, vol. 25) recommends taking advantage of these timely clues to increase **cost consciousness** and the understanding of the cost effect of specific **causes of higher cost.**

CONSULTATION. Cost accountants and other staff personnel responsible for installing and operating a cost control system need to consult frequently with

first-line foremen or department heads so that the system will provide significant information which is helpful in improving the utilization of men, materials, and machines. Dudick (NAA Bulletin, vol. 36) emphasizes the primary importance of a thorough basic understanding of physical operations and of the interchange of ideas between the cost accountant and production supervisors.

ACTUAL COSTS. Since they are a quantitative expression of actual performance, actual costs play a role in measuring performance to obtain clues for cost control actions. It is generally recognized, however, that past actual costs are not the best yardstick for measuring current performance. Oles (NAA Bulletin, vol. 35) expresses this viewpoint as follows:

> It may be said that there are three outstanding arguments against simple comparison of present with past. First, a comparison with totals made up of details which have altered is a poor comparison. This is merely another way of saying that the comparison upon which so many executives place great stress is of no real value, since it deals with an entirely different set of conditions. Second, prior year figures may be difficult to compile in accordance with the current classifications used for accounting. If any semblance of similarity of basic data is to exist, an attempt must be made to reclassify prior figures, taking into consideration not only changes which have occurred but the rearrangement of data required to meet present conditions. Third, prior year records of performance may never have represented satisfactory performance. There is nothing in prior year figures, as such, to indicate that they are worth using as a standard of comparison. These standards must be independently constructed, and neither budgetary control nor cost reduction can be effectively secured without them

Some contend that even a reporting of **actual cost performance** compared with a **budgetary or standard yardstick** does not of itself provide control. Anthony (Accounting Review, vol. 32) states that it is primarily the foreknowledge of supervisors that they are going to be measured which produces control.

> Cost reports describe what has already happened; therefore they cannot be used to control events, since no one can alter or undo what has already been done; therefore, a control report cannot really control anything.
>
> One explanation of this apparent paradox is obvious, namely, that cost reports provide the basis for actions such as praise, criticism, or suggestions for change, all designed to improve future performance. We think, in addition, there is another, more subtle way in which cost reports influence performance, and indeed influence the very performance being reported on. Advance knowledge of the fact that a report on performance is going to be prepared can be an important stimulus to good performance on the part of the person being judged.

PHYSICAL MEASUREMENTS AND STATISTICS. Regular reports of physical measurements (amount of material used in gallons, pounds, feet, etc., amount of materials wasted, units spoiled, labor or machine hours used, idle man or machine hours, units transferred from operation to operation and to finished goods) are necessary for effective **quantity control,** which is the basis for proper accounting and cost control. Gillespie (Cost Accounting and Control) stresses the primary importance, and some uses, of physical measurements.

Quantity control is intended to provide safeguards at a number of points. In the first place, it is a safeguard of the accuracy of the **unit product costs** computed by the cost department. If the quantities on which unit costs are based are wrong, the unit costs are wrong. Quantity control is intended to ensure the accuracy of quantities used by the cost clerk.

Quantity control is a means of protection against excess **incentive wage payments.** When a piece-rate wage payment plan is used, the quantities reported to

the payroll department for labor payment are usually checked against quantities produced as shown in the production and cost records. Likewise it provides indication of shortages in materials on hand that may have been caused by loss, theft, unauthorized use, or unauthorized shipment.

While such information is customarily only used monthly to derive figures for the flow of costs through appropriate general ledger accounts, it needs to be known daily and weekly in order to achieve better utilization of a firm's resources through the efforts of the **production planning department** and of those executives and supervisors concerned with taking cost control actions in **production operations.**

STATISTICAL QUALITY CONTROL. Through the use of statistical **sampling** techniques and **probability** theory, physical measurements of actual use can be related to one another or to standard physical requirements. Such statistical interpretation can assist management in focusing on those factors of production which are out of control.

Statistical methods are applicable where measurements are subject to variation. Measurements of spoilage, waste, man-hours required per unit, etc., will vary in an operation despite careful planning and attempts to standardize and control all the variables of production. Men, materials, and machines are fallible, and working conditions are not always identical, and so all are subject to individual variations. The laws of probability have been applied in so many of the physical and social sciences that it may be said that the laws of probability provide an almost universal yardstick for measuring and controlling variation. Sampling techniques, which are based upon the mathematical laws of probability, offer a good deal of promise for increasing the effectiveness of managerial accounting and for reducing the cost of cost control.

In recent years statistical investigations have been made and applications developed and refined by various types of businesses, governmental agencies, and public accounting firms. This experience has served to establish the applicability and usefulness of statistical techniques over a wide range of problems. Hart (NAA Bulletin, vol. 38) asserts that this demands that members of the accounting profession re-examine their **data processing criteria**:

> In data accumulation and processing, unnecessary costs are often incurred because accounting standards of accuracy are used in the quantification of data for planning and control. However, management seldom needs the same high accuracy for control, which is required when accounting for the company's cash. Hence, before information is gathered and processed, accountants should determine just what degree of precision is required for planning and control. In so doing, they cannot afford to neglect scientific techniques which are being successfully used in other professions where the problems of analysis and interpretation are just as difficult as in the accounting field.

Vance (NAA Bulletin, vol. 36) predicts that relatively small firms, which cannot afford elaborate control techniques, may find that **sampling techniques** will prove a satisfactory substitute:

> Where a substantial volume of product is made or some process or operation is done frequently and no continuous, formal cost accounting is done, we can gather cost information and, therefore, exercise cost control by estimating the unit cost from a sample. For example, we may take a sample of time cards for a certain operation and estimate the unit labor cost from them for the period in question. Note that this invokes all the advantages of other applications of sampling theory. We can determine how large a sample to take to give the degree of precision we want in the estimate. We can balance the cost of the sampling against the quality of the result

we want. We can use the devices of scientific sampling to determine what items to include in the sample. We can eliminate. if we are careful, the biases that result from use of personal judgment alone in selecting and evaluating samples. In view of the fact that complete, formal cost accounting is often considered much too expensive to justify its use in small industrial operations, this should appeal to many cost accountants and to many managements as a means of obtaining cost data scientifically at a very reasonable cost.

A **standard cost** system is one of the most important tools used in controlling costs. Three sections of this handbook are devoted to this subject, the sections on Setting Standard Costs, Operation of Standard Costs, and Analysis and Control of Standard Cost Variances. The last section includes a discussion of the use of statistical techniques in determining which variances from standard require investigation and corrective action.

Budgeting

FUNCTIONS OF MANAGEMENT. All business enterprises are established and operated for the purpose of attaining certain basic objectives which will not generally be realized without effective direction. Success of a firm seldom occurs by accident; rather, it usually results from careful attention to all phases of operations by those who are charged with the responsibility for managing the enterprise.

With the increasing size and complexity of industrial organizations, the need for scientific management has become more evident. It should be added, however, that **scientific management,** as Welsch (Budgeting: Profit-Planning and Control) points out, "does not involve a formalistic, highly complicated system of business management," but does include "the processes of investigation, analysis, and decision."

Similarly, Davis (The Fundamentals of Top Management) states that, "managerial functions involve the work of planning, organizing, and controlling the activities of others in accomplishing the organization's objectives." Thus these broadly conceived functions include **formulation of plans, coordination of activities** dictated by the plans, and **control of operations.** All three are complex and interrelated. Furthermore they are made increasingly difficult by changing economic conditions, government regulations, customer needs, and technological advances.

For these reasons, management should know where it intends to go (objectives), the requirements for getting there (plans), means by which it may meet these requirements (coordination through organization), and in addition provide for constant vigilance over execution of the plans (control). To carry out these functions effectively, management must formalize its plans in such a way that a basis for coordination and a means for appraising the actual results of operations are provided.

Management must therefore have at its disposal various tools, techniques, and procedures which provide information useful in decision making. **Comprehensive budgeting** is one of these tools and is generally recognized as most useful for planning, coordinating, and controlling enterprise activities.

DEFINITION OF A BUDGET. Numerous definitions of a budget have been formulated, but common to all is the essential idea that a budget is a written plan covering projected activities of a firm for a definite time period. A team of 34 European experts from eleven different countries, who made a survey of how

accounting was performed in the United States (Cost Accounting and Productivity: The Use and Practice of Cost Accounting in the U.S.A., OEEC), has defined the budget as:

A plan of operation expressed in monetary terms; it consequently includes a forecast of income and expenditure and of receipts and costs for a specific period, usually 12 months. This notion of a plan of operation is most important; and it is here that this form of budget differs markedly from budgets of public services, the main purpose of which is to fix allocations which spending departments must not exceed.

Others have emphasized similar ideas:

A budget is a plan for coordinating the various operations of a business expressed in financial terms. (Lang–McFarland–Schiff, Cost Accounting.)

Budgeting is, basically, only a plan of operation, and even the most rudimentary business effort has to be motivated by some type of plan. (Loncar, NAA Bulletin, vol. 37.)

Heiser (Budgeting—Principles and Practice) defines a budget as the over-all statement in financial terms of a comprehensive plan of operations and actions. A budget can function as a device not only for planning and coordination, but also for control, according to Heiser, if it is adequately prepared and fully used. It is Heiser's opinion that the common practice of applying the term "budget" to mere segments of the comprehensive, master plan is unfortunate because it leads to confused thinking. He prefers to use the term **budget schedules** for the segments. Thus he refers to a listing of budgeted sales as a schedule of budgeted sales rather than as a sales budget.

A comprehensive budget includes the separate plans made for the various segments of the enterprise. Through its development, the several division plans are synthesized so that the end result is a unified plan for the firm as a whole. The comprehensive budget provides estimates of revenues, costs, and expenses for the time period, including plans for such other items as cash requirements, inventory levels, and capital additions.

In view of its nature, a budget is related to both accounting and management. It deals with information which must be based, at least in part, on data derived from accounting records and which must be reported concurrently with results of operations for their full potential to be realized. Furthermore the budget is closely associated with all phases of operations which are directed by management and which must be implemented through the organization.

OBJECTIVES OF BUDGETS. Accounting provides information to management as well as to many groups external to the firm, such as stockholders, governmental agencies, potential investors, and creditors. Budgets, however, are tools designed principally for internal use and therefore should be developed accordingly. They can be justified only if they serve management. Welsch (Budgeting: Profit-Planning and Control) writes:

Dynamic budgeting is the principal tool of planning and control offered to management by the accounting function; its usefulness increases with the complexity of the organization. It also is the accountant's open door to the inner councils of top management. This mutual enrichment of function between management and accounting is a vital feature in the successful life of progressive enterprises, but its full potential frequently is hindered by the gap between the mechanics of budgeting and their practical application to the problems of modern management.

In emphasizing the usefulness of budgets, it must be kept in mind that budgets are an aid to managerial judgment, not a substitute for it. As Heiser (Budget-

ing—Principles and Practice) states: "A budget is not designed to reduce the managerial function to a formula. It is a managerial tool."

For budgets to be effective, management should be conscious of the benefits to be derived therefrom. Furthermore it should participate actively in **budget development** to (1) impress upon everyone concerned the importance of the project, and (2) ensure that the budgets are constructed in such a way that they will be useful in carrying out the functions of management.

Budgets are instruments designed to aid management in planning, coordinating, and controlling operations. According to Heiser (Budgeting—Principles and Practice) the budget of the company serves three purposes:

> First, it provides top management with a summarized picture of the results to be expected from the proposed plan of operations. This aids the management in determining whether the plan is satisfactory. Second, following approval, it serves as a guide to executives and department heads responsible for individual segments of the operations. Third, it serves to measure performance, since budget deviations reflect either the organization's failure to achieve the planned standards of performance or its ability to better them.

Heckert and Willson (Business Budgeting and Control) detail by functional areas the **reasons for budgeting,** as follows:

Planning:

1. To base action upon thorough investigation, study, and research
2. To enlist the assistance of the entire organization in determining the most profitable course
3. To serve as a declaration of policies
4. To define objectives.
5. To stabilize employment.
6. To make more effective use of physical equipment.

Coordination:

1. To coordinate human effort within the business structure.
2. To relate the activities of the business to the general trend of economic conditions.
3. To direct capital and effort into the most profitable channels by means of a balanced and unified program.
4. To reveal weakness in organization.

Control:

1. To control specific operations or expenditures.
2. To prevent waste.

Even though different firms may stress some of these objectives more than others, substantial benefits may still accrue through the use of budgets. All the reasons for budgeting are important, and if those which are emphasized in a particular firm are realized, the effort involved will have been worth while. For example, budgets may occasionally be used primarily for **multiple-unit coordination.** If this task can be more easily accomplished through budgets, then their use in this connection can be justified, even though they may not be utilized for other purposes. In other instances, budgets may be used principally as a **control device** for signaling areas of operations which may need further investigation and perhaps corrective action. It should be recognized, however, that the full potential of budgeting cannot be realized unless it is extended into all areas of the firm's activities and used to assist management in its functions of planning, coordinating, and controlling operations.

Participation in Planning. In some way, all successful firms must plan, and a budget will be helpful in this phase of management activity. By requiring plans to be put down in writing, what has perhaps formerly been a vague idea must now be thought through carefully. In so doing, gaps in thinking may be disclosed and corrected. Furthermore, it may be found that unwritten plans of the several segments do not fit together and therefore must be adjusted.

The participation of all members of management in building the budget may perhaps underscore the central objective and give a clearer insight into how each division fits into the **over-all budget plan.** This kind of knowledge and participation gives a sense of being part of an effort greater than the one with which each is intimately associated. They may also contribute to a better understanding of the problems of other departments. Out of this may emerge a team effort, the results of which may be difficult to measure but nevertheless be quite real. Plans which are drawn carefully for each segment of the business, synthesized properly, and developed with and agreed to by all members of management will usually result in a greater effort to realize them than will haphazard plans based on incomplete and perhaps faulty data poorly communicated.

Coordination of Effort. The extent to which a firm uses its resources effectively will in a large measure determine its success. The greatest resource available to the enterprise is human effort. But it must be directed to specific objectives; human effort must be coordinated. This is one of the most difficult jobs with which management is confronted. It is therefore important that plans be developed to provide a basis for systematic direction of the activities. Coordination of efforts requires **communication of objectives and instructions,** and a budget is one very important means of communication.

Methods of Control. The great challenge to the modern executive is the control of day-to-day operations. Many companies have found that this challenge cannot be successfully met by informal methods which emphasize the experience and abilities of key executives who have had a good average in making correct decisions based on incomplete information. Methods and devices for aiding management in its control function, therefore, should be constantly studied and developed. Plans may have little meaning if they do not provide guides to management action.

A basic ingredient of control is an **advance estimate** of what an operation, or a product, or a special project should cost, since control implies the comparison of an actual cost with an estimate of what it should have cost, followed by appropriate corrective action. A budget, when carefully developed in the light of all pertinent considerations and continually revised in terms of changing circumstances, provides management with estimates of what operations, processes, and products should cost. The development of a budget, when coupled with a sound organization, provides a strong basis for control.

It should be recognized, however, that control is exercised by people and that the mere preparation of a budget will not ensure its effectiveness. For this reason, budgets should be prepared in a form and in terms understandable by those who are expected to have their performance measured by it.

Of considerable importance is the fact that budgets are adaptable to all kinds and sizes of businesses. Undoubtedly, the more complex the organization, the more necessary becomes the use of budgets. On the other hand, they have much to offer to the small manufacturer, since he also must have yardsticks by which to measure the performance of every phase of his business activity. Very small producers will probably find that **informal estimates** will suffice, but the effi-

ciency of their operations may be improved through **systematic plans,** even though such plans may not be determined by the most refined methods.

In summarizing their Controllership Foundation study of 424 companies, Sord and Welsch (Business Budgeting) state:

> This study clearly reveals that budgeting is one of the best approaches for obtaining coordination of the various factors of production in the individual business enterprise. This study also shows that budgeting is a technique adaptable to the needs of practically all sizes and types of business. The widespread use of budgeting attests its value as a planning and control technique. There seems little doubt that the use and refinement of this technique will increase as the American economy continues to grow.

TYPES OF BUDGETS. Because budgets are called upon to serve different purposes, different types of budgets have been developed. Representative primary budget classifications distinguish between (1) **program and responsibility budgets,** and (2) **capital and operating budgets:**

> It is safe to say that in a company that has a complete budgeting program, one would expect to find two types of budgets, a "program" budget and a "responsibility" budget. . . . The program budget sets forth plans in terms of the major "programs" the company plans to undertake. . . . The responsibility budget sets forth plans in terms of the persons responsible for carrying them out. (Anthony, Management Accounting.)
>
> [Budgets] may be divided into main classes: (1) capital budgets, directed toward proposed expenditures for project activities, and (2) operating budgets directed toward planning and controlling program activities. . . Operating and capital budgets may also be classified by type into (a) appropriation, (b) forecast, and (c) flexible budgets. (Kohler, A Dictionary for Accountants.)

Both writers emphasize the same general types of budgets in a **comprehensive budgeting program.**

Fixed Budgets. Business budgets are often classified into fixed or **static budgets** and flexible or variable types. A fixed budget is one which is prepared for one level of activity for a definite time period. The chief characteristic of such a budget is that it is not adjusted to actual levels of activity when comparisons are made with actual results of operations. A fixed budget may be satisfactory when the company's activities can be estimated reasonably accurately, but at best it has limited usefulness as a control tool. Actually, a fixed budget is subject to revision, and therefore it should be looked upon as one which is fixed only in the sense that it is not adjusted to reflect data for the actual level of operations.

Flexible Budgets. A flexible, or **variable,** or **sliding scale budget** is one which is constructed in such a way that it will be possible to determine budgeted costs for any level of activity. A flexible budget is much more useful as an aid in controlling operations than is the fixed or static budget. In this connection, Devine (Cost Accounting and Analysis) writes:

> The flexible—sliding—budget is the most effective instrument used by accountants to aid in control of factory overhead costs. The flexible budget should not be confused with the general coordinating budget, which is essentially the expression of a plan of action that enables management to coordinate the producing, distributing, and financing functions of the business.

If a company operated at 10,000 hours of activity, it would make little sense from a control standpoint to compare costs budgeted for 15,000 hours with those

actually incurred for 10,000 hours. The significant comparison, of course, would be one which related budgeted and actual costs to the same level of activity.

Flexible budgets are principally designed for use in controlling costs and expenses as related to production and sales. **Sales forecasting** is one of the activities which must be carried on in a comprehensive budgeting program, but emphasis in flexible budgeting is on costs and expenses. The fixed budget, subject to revision, will be used for sales and other detailed budgets such as **cash requirements** and **capital additions.** Nickerson (Cost Accounting) brings this point out as follows: "Since both types of budgets have their particular uses, there is no point in arguing for either a fixed budget or a variable budget to the exclusion of the other . . ."

Development of Flexible Budgets. In order to develop flexible budgets, some knowledge of cost behavior is important. Two approaches are available for constructing such budgets. One requires the separation of costs into **fixed** and **proportionately variable** components. In the total for manufacturing burden, it may appear as follows:

Annual Capacity — 12,000 direct labor hours

Item	Total	Rate
Fixed costs	$ 7,200	$0.60
Variable costs	4,800	0.40
Total	$12,000	$1.00

Thus, if a firm operated in one year at 8,000 direct labor hours, the budgeted burden would be $10,400, made up of fixed costs of $7,200 and variable costs of $3,200 (8,000 hours × $.40). Although the preceding budget has been shown in total only, an actual budget would include each type of fixed and each type of variable cost.

It is doubtful if costs can be separated into those components which are literally fixed or variable. On the other hand, it is perhaps possible to make a tentative separation which will be sufficiently satisfactory within the probable ranges of output for use in making managerial decisions. (For a complete discussion of fixed and variable costs, see section on Accumulation of Manufacturing Overhead.)

Under a second approach, a flexible budget may be developed for specific **levels of activity**; for example, 40%, 50%, 60%, 70%, and so on, with estimates being made of what the costs should be at these levels of activity. When this approach is followed, not all costs are necessarily separated into those which are fixed and those which are variable. If the actual level of activity is equal to one of the levels for which costs have been budgeted, no difficulty is encountered in determining the budgeted costs at that level of activity for comparative purposes.

On the other hand, if the actual activity is at a level for which the budget does not show costs, it will be necessary to interpolate in order to obtain the budgeted costs at that activity. If the actual activity is only slightly different from that for which costs are budgeted, no significant differences will occur if the budgeted costs for the actual level are assumed to be the same as those listed on the budget for the activity level nearest to the actual level attained. Thus, if costs are budgeted for 80 and 100 percent of capacity, and the actual activity is 81 percent of capacity, budgeted costs at the actual activity level may be assumed to be the same as those budgeted for 80 percent of capacity because the small difference of 1 percent is not sufficient to change significantly the total budgeted costs.

Interpolation, of course, may not be precisely correct, although reasonable results can generally be obtained by its use. Interpolation between levels of activity assumes that variable costs vary proportionately with activity in the range under observation. This may or may not be true.

A brief flexible budget of the latter type, totaled by **cost behavior classifications,** is given in the accompanying table.

	Percentage of Capacity			
Costs	70%	80%	90%	100%
Fixed	$1,000	$1,000	$1,000	$1,000
Semi-variable	600	650	750	950
Variable	700	800	900	1,000
Total	$2,300	$2,450	$2,650	$2,950

The care used in determining costs included in a flexible budget will often directly influence its usefulness. Costs which reflect detailed study and which purport, within the area of human limitations, to represent what the costs should be will be more effective in the control of operations than costs which have been determined on the basis of past performance adjusted by rough estimates. Schlatter and Schlatter (Cost Accounting) emphasize that:

> . . . Not all budgets are standard budgets. Standard budgets show the amount of costs that should be incurred. Other budgets may be drawn up to show the amount of costs expected to be incurred, which may be quite different from the amount of costs that should be incurred. A standard budget is required for the best cost control, although a budget showing expected costs is usually better than no budget at all.

Appropriation Budgets. Another type of budget, encountered particularly in governmental operations, is the appropriation budget. Such a budget may also occasionally be used by businesses, especially in connection with **advertising, capital additions,** and **research.** The distinguishing characteristic of an appropriation budget is the limitation set on expenditures included in such a budget. The amount budgeted becomes the maximum amount which can be expended for the items in question. This type of budget has only limited usefulness for business operations, and if rigidly adhered to, may sometimes result in unwise expenditure of funds. It is fundamental that a business budget must have some degree of flexibility; otherwise, unsound practices may be followed.

General Use of Budget Types. All three types of budgets—fixed, flexible, and appropriation—may be found in use in business concerns. Some firms may employ all three, while others may use only one type. This use may range from development of only a **forecast budget** all the way to adoption of a **complete budget system** in which operating controls are incorporated. Anthony (Management Accounting) says, "There is a tremendous variation in the way in which budgets are prepared in different companies; in fact, the diversity in budgeting practice is much greater than the diversity of accounting practice."

BUDGETARY CONTROL.

As Matz–Curry–Frank (Cost Accounting) have stated, "the terms 'budgetary control' and 'budgeting' are frequently used interchangeably."

Definition of Budgetary Control. Budgetary control in its broadest sense means the use of a comprehensive system of budgeting to aid management in carrying out its functions of planning, coordinating, and controlling operations. A group of European experts (Cost Accounting and Productivity: The Use and

Practice of Cost Accounting in the U.S.A., OEEC), after visiting many American firms selected for their good managerial practices, wrote:

> Budgetary control consists in comparing estimates of income and expenditure with the actual returns. The control embraces every budget, including the profit and loss budget and the cash budget, and records are compiled showing the annual and monthly estimates, actual income and expenditure, the difference between the estimates and actual income and expenditure, as well as the percentage variation.

On the basis of their long experience in various European countries they observed:

> Forecasts and estimates are not new to the business world. . . . What is original in America is the precision of the methods used, the budgets being drawn up on the basis of a meticulous and systematic analysis of the component industrial and commercial operations. Few European firms draw up budgets in this meticulous way or use them as an instrument of management control.

Sometimes the term "budgetary control" is restricted to the use of budgets as instruments for providing information to be used as bases for comparisons between costs incurred and costs which should have been incurred. In this context then, budgetary control is (1) the signaling of costs which differ from the budget, and (2) the following up of significant variations with corrective action by management. (See the sections on Materials, Labor Costs, and Manufacturing Overhead and Normal Activity for budgetary control of these costs.)

Peirce points out (Harvard Business Review, vol. 32) that a good administration of budgets permits common-sense departures from the budget. When a situation makes an unbudgeted expenditure desirable, the manager concerned will not hesitate to recommend it if he is satisfied that it will prove beneficial to the company, thus not permitting the budget to control mechanically.

Advantages and Limitations of Budgets. Certain advantages and limitations of a **budgeting program** have been adapted from Welsch (Budgeting: Profit-Planning and Control) as follows:

Advantages:

1. A budgeting program forces early consideration of basic policies.
2. Adequate and proper organization is required; that is, definite assignment of responsibility for each function of the business.
3. All members of management from the top down must participate in the establishment of goals.
4. All members of departmental management are compelled to make plans in harmony with plans of other departments.
5. Management is forced to put down in cold figures what is necessary for satisfactory results.
6. Management is compelled to demand adequate historical accounting data.
7. Management must plan for the most economical use of labor, materials, facilities, and capital.
8. The habit of timely, careful, and adequate consideration of all factors before reaching important decisions is instilled at all levels of management.
9. The cloud of uncertainty that exists in many firms among lower levels of management, relative to basic policies and objectives, tends to be removed.
10. The extent or lack of efficiency is pinpointed.
11. Understanding is promoted among members of management of their co-workers' problems.
12. Management is forced to give timely and adequate attention to the effect of the expected trend of general business conditions.
13. A periodic self-analysis of the company must be made.
14. It aids in obtaining bank credit.
15. Progress or lack of progress toward the objectives must be checked

Limitations:

1. Estimates are used as a basis for the budget plan.
2. A budgetary program must be continually adapted to fit changing circumstances. Normally it takes several years to attain a reasonably good budgetary program.
3. Execution of a budget plan does not occur automatically. All levels of management must participate enthusiastically in the program.
4. No budgetary system will eliminate the necessity for superior executive ability in every major business decision.

The team of European experts (Cost Accounting and Productivity: The Use and Practice of Cost Accounting in the U.S.A., OEEC) concluded its observations on budgeting in American companies with the statement:

The working of the budgetary procedure in the firms visited shows clearly that it takes time to install a sound budgeting system in an undertaking. Several years may elapse before it is fully adopted, but it is able to fulfill part of its purpose from the start.

When budgeting is first introduced, some difficulties are usually encountered, but experience has proved that those who have persevered in spite of these difficulties have not regretted it.

BUDGET DIRECTOR AND BUDGET COMMITTEE. For a budget to be effective in the accomplishment of its end objectives, it must be properly developed and utilized. The budgeting program must be soundly administered. Budgeting is a management function, and its success depends in no small way on the support given this important function by top management. As a matter of fact, such a program will probably be doomed to failure from the outset unless the chief executives give it their whole-hearted support.

With reference to the **organization for budgeting**, Heiser (Budgeting—Principles and Practice) observes:

Because of the number of persons involved in preparing a budget, and the various interrelated actions and decisions, coordination becomes a problem and requires the setting up of a budget office. The budgetary system is a complicated mechanism, and a governor must be provided to ensure that it works smoothly and effectively. Some executive must be assigned this responsibility to ensure that budgeting is properly organized and carried out.

Primary responsibility for the administration of a budget is usually delegated by top management to an executive, variously known as the budget director, budget officer, or assistant to the president. Heiser indicates that, "This executive may be the controller or a separate coordinate executive appointed to function solely as a budget officer."

The general **duties of the budget officer** are (1) to coordinate the efforts of those engaged directly in the preparation of the budget, (2) to prepare budget reports, (3) to recommend such courses of action as may be indicated by the budget, and (4) to make special studies pertaining to the budget. Hennessy and Roberson (NAA Bulletin, vol. 38) give the responsibilities of the budget director in the Stromberg-Carlson Division, General Dynamics Co., as follows:

The budget director is responsible for the final presentation and interpretation of the company financial plan. . . . Further, the budget director is responsible for the development and revision of the budget procedures and issuance of instructions pertaining to schedules and general activity of his staff.

The budget director is a staff officer and as such should exercise no line authority except with his own personnel. Furthermore the development of the

budget should not be a job delegated to the budget officer but rather one that is supervised by him. The budget will be the product of the efforts of all levels of management, but these efforts should be coordinated and supervised by the budget officer.

Position in Organization. Various arrangements have been recommended as to how the budget officer should fit into the over-all organization. At least two possibilities exist, and both are supported by different groups with deep conviction. Some authorities recommend that the budget director be completely separated from the accounting function, not only physically and in terms of duties, but also in the chain of command. These writers usually insist that the budget director should report to the chief executive or his immediate subordinate. Thus, Lamperti and Thurston (Internal Auditing for Management) emphasize that "the budget function should be set up separately from accounting and should not come under the supervision of the comptroller." Loncar (NAA Bulletin, vol. 37) writes that in the Vendo Company the "budget program is . . . set up as a staff function reporting directly to the office of the president or the executive vice-president of the company."

Another group seems to believe just as strongly that the budget officer should report to the president through the accounting organization. Heckert and Willson (Business Budgeting and Control) assert that: "In most companies this is the function of the chief accounting official, the controller. . . . In large concerns an official may be designated to devote his entire time to budgeting. Such an official should generally be under the jurisdiction of the controller."

The Controllership Foundation study by Sord and Welsch (Business Budgeting) shows that of 379 companies with formal budget programs, 40 percent have a budget director (or an individual with a very similar title) who coordinates the budget program (70 percent of these directors in turn report to the controller). The controller or assistant controller coordinates the budget program in 34 percent of the reporting companies; in 8 percent of the companies it is the treasurer or assistant treasurer who has this responsibility; and in the remaining 18 percent the budget coordinating is done by persons with a variety of miscellaneous titles.

Regardless of the position of the budget officer within the organizational set-up, his chief objective is the proper administration of the budget. In some companies it may be accomplished successfully with one organization plan and in other companies with another. It will be necessary, however, for the budget officer to work in close cooperation with the accounting department

Functions of Budget Committees. In some companies a budget committee composed of executives in charge of the major functions of the business may be found to be a useful device for coordinating and reviewing the budget program, particularly as related to general policies which affect the budget. The budget committee is generally advisory in nature and is charged with the following functions:

1. To receive and review individual budget estimates.
2. To suggest revisions.
3. To decide on general policies affecting more than one primary department.
4. To approve budgets and later revisions.
5. To receive and consider budget reports showing actual results compared with the budget.
6. To recommend action where necessary.

This committee may thereby become a very powerful group in coordinating the activities of the firm and in the synthesizing, if not development, of policy.

Budget Preparation

ESTABLISHMENT OF BUDGETARY SYSTEMS. A successful budgeting program can be carried out only when certain fundamental conditions and attitudes exist. Effective budgeting rests upon a sound organization, adequate accounting records and procedures, full support of top management, a continuous program of education in the uses of budgets, continuing study of budget and control problems, and revisions of budgets when appropriate. Clear-cut organization lines should be established with appropriate delegation of responsibilities. Satisfactory working relationships between supervisors and subordinates must be developed throughout the firm. As Heiser (Budgeting—Principles and Practice) expresses it:

> Budget preparation is a cooperative action embracing all levels of management. Top management indicates the desired immediate objectives. Lower management levels then work out the details, both to test the feasibility of the indicated objectives and to ensure coordination of all the parts. As a result of this effort, changes in the objectives may be indicated. Thus the preparation involves not only cooperation but also an up-and-down or reciprocating adjustment of objectives and plans to achieve a realistic and workable program, as nearly as possible in line with the company's long-range plans.

The following **requirements for a good budgeting system** have been adapted from Draper (Journal of Accountancy, vol. 97):

1. Budgeting must have the complete cooperation of the chief executive.
2. The ultimate realization of the greatest amount of profit should always be kept uppermost.
3. The budget director must be a good salesman. The budget must be sold up and down the line.
4. Responsibility for the preparation of the estimates should rest on those individuals responsible for performance.
5. The budget must be realistic and the goals attainable.
6. A budget committee should be established consisting of the budget director, the chief executive officer, and the executives of the various divisions of the organization.
7. The budget should cover all phases of operations.
8. Budgeting should be continuous.
9. Periodic reports should be prepared promptly, comparing budget and actual results.
10. The accounting system must be adequate.
11. A good organization must be developed.

These requirements are usually emphasized in the establishment and operation of a good budgetary system. Welsch (Budgeting: Profit-Planning and Control) emphasizes the need for fitting the budget program to the peculiarities of each firm and for making changes in the system as the firm grows or changes. He observes, "It is doubtful whether any two budget programs should be identical, for the obvious reason that no two concerns are identical in every respect."

RELATIONSHIP OF BUDGETING TO ACCOUNTING. Since budgeting cuts across all segments of the company, it is clearly a management function. Yet it inevitably is related to information which will be developed and processed through the accounting department. For this reason procedures must be developed so that budget information and operating data can be collected similarly.

The chart of accounts should be given careful study to ensure that the **classification of accounts** will be such as to make possible the collection of both budget and historical data in like manner. Much of the effectiveness of a budget program will be lost if these two types of information are not reported on the same bases, or if considerable analyses must be undertaken to convert these data for comparative purposes. Studies of the **chart of accounts** and related classifications may indicate the need for a revision of accounting procedures consistent with the requirements of budgetary control.

Heiser (Budgeting—Principles and Practice) emphasizes the importance of a sound **accounting structure** to budgeting and gives the following specific **functions of accounting** in budgeting:

1. To equate all planned transactions in terms of:
   a. Revenue, costs, and profit.
   b. Financial position at end of selected periods, as shown by forecast balance sheets.
   c. Sources and application of funds, as shown by funds statements.
   d. Cash flow, as shown by statements of estimated cash receipts and disbursements.
2. To provide some data and to price other data for use in preparation of the budget.
3. To show the effect on profit and financial position of alternative courses of action.
4. To report, in profit and financial terms, performance under the plan.

Standard costs and budgets complement each other in various ways. The development of standard costs will provide a sound basis for budgeting. Their use will tend to enhance the accuracy of budgets and will facilitate their preparation. Ideally, standard costs should be made an integral part of the budget program, that is, in its preparation as well as in its use as a control device. (For a further discussion of the relationship between budgets and standard costs, see section on Setting Standard Costs.)

BUDGET PERIOD. Prior to the actual preparation of a budget, the time period involved must be determined. Different types of budgets (for example, **long-range planning** and **short-term control** budgets) are designed with different objectives in mind. The time period covered will therefore of necessity not be the same for all budgets, yet it must be definitely established.

Length of Period. Matz–Curry–Frank (Cost Accounting) point out that the following factors should be considered in determining the length of the budget period:

1. For a business of a seasonal nature, the budget period should cover at least one entire seasonal cycle.
2. The budget period should be long enough to complete production of the various products.
3. The budget period should be long enough to allow for the financing of the production well in advance of actual needs.
4. Major operations and drastic changes in plant layout or manufacturing methods must be planned far in advance to determine financial requirements.
5. The budget period should coincide with the financial accounting period in order to compare actual results with the budget estimates.

For those companies whose business life is broken down into definite annual units (for example, firms which introduce new models each year), an **annual**

budget is logical. Other firms may develop new products for each season and will therefore find most satisfactory a budget period which equals the length of the season. Enterprises which have highly seasonal sales but do not have **style seasons** or **model years** will find the annual budget to be the most useful. Without such a budget it will be difficult to appraise the results of operations. What is needed under such circumstances, for forward planning, is a picture of the year as a whole.

Where the business is not highly seasonal, does not introduce new models annually or have style seasons, budgets may be prepared for varying lengths of time in accordance with the objectives desired. Many companies develop a long-range budget which sets forth their major objectives for a period from three to five years or more. Subsequently, the annual budget will be broken down into shorter fiscal periods ranging from a week to a month or to a quarter of a year.

The Controllership Foundation study by Sord and Welsch (Business Budgeting) showed that of the 375 companies in this survey that disclosed the length of their budget period, 86 percent reported that the budget covered one year; 10 percent indicated a 6-month period; and 4 percent a 3-month period. Most of the companies studied subdivide their budget into a series of **interim time periods** to aid in both planning and control. Monthly periods are used by 79 percent of the companies reporting on the subdivision of the budget period; 17 percent use quarterly periods; 1 percent use weekly periods; 1 percent employ 4-week periods; and 2 percent use the annual period only.

Coordination of Sales and Production. A budget for the year will give a picture of the over-all plans, whereas a budget for a shorter time period will make possible a determination of the contribution by each such period to that objective. A **short-period budget** provides the basis for detailed coordination of production and sales that would otherwise be difficult if not impossible. Operations can usually be planned satisfactorily on a monthly basis, and the budget for the month can be made to serve as a guide for the day-to-day decisions. Analysis on a monthly basis is therefore common.

In establishing the budget period, attention should also be given to the synthesis of sales and production. For example, producers of branded hosiery may manufacture goods in the fall and winter for sale in the spring. Under these conditions, if the budget period ends on December 31, some benefits of budgeting may be lost. The use of a **natural business year** for budgeting and accounting assists in making both accounting reports and budgets of greater value to management.

Time Plans for Budget Preparation. Neuner (Cost Accounting) summarizes time plans for preparing budgets as follows:

1. **A long-range planning period covering several years.** Such a program would affect company expansion policy in the matter of new products and the matter of investment in new plant and equipment.
2. **Over-all planning for the fiscal accounting period.** Usually this is for one year and refers to the master budget, since it sets forth the operating plans and profit objective for the coming fiscal period.
3. **A month-to-month-basis budget** which, because of the shortness of this period, will be the most effective in controlling costs, sales, and selling expenses.

BUDGETING PROCEDURE. After the task of organizing for the budgeting process has been accomplished and the time period has been selected, the actual preparation of the budget must be undertaken.

Lang–McFarland–Schiff (Cost Accounting) list the following steps ordinarily taken in **budget development:**

1. Making a sales forecast which largely determines how much is to be spent for selling and what quantity of goods must be made available.
2. Preparing a production budget which comprises planning needs for materials, labor, and manufacturing facilities, together with the costs of these items.
3. Preparing a plan to meet financial needs of the business, including cash for payrolls, creditors, dividends, capital additions, etc.
4. Assembling and coordinating individual budgets into a master budget.
5. Reporting current performance and comparing it with the budget. Management is kept informed of progress relative to the budget by these reports.

Preparation of the budget usually will begin with **sales forecasting.** This is the primary estimating factor, and from it will be developed plans for materials acquisitions, consumption, and inventories, as well as labor requirements and the anticipated cost. The flexible **manufacturing burden budget** should also be adjusted to the expected sales volume and combined with the materials and labor budgets into a comprehensive budget for manufacturing operations.

At the same time these budgets are being prepared, budgets for other items such as commercial expenses, capital additions, and research costs may be completed. In addition, needs for cash, as indicated by the preceding budgets, should be determined and plans made to ensure the availability of cash as required.

Heiser (Budgeting—Principles and Practice) lists the various budget plans and the departments involved in their preparation in Fig. 1. In Fig. 2 Heiser shows which budget schedules affect others. The illustration demonstrates the need for integration of the various budget schedules, and Heiser states, "All the plans must be prepared on the basis of common knowledge, not only of the general directives, but also of the specific plans of related departments."

Upon the completion of the several individual budgets, they should be brought together in a **combined or master budget.** This will serve as a basis for the preparation of a **budgeted income statement** and **budgeted balance sheet.**

DEPARTMENTAL RESPONSIBILITY. Primary responsibility for preparation of the budgets should rest with the supervisors of the various segments of the business. For example, the sales forecast should be developed by the department charged with the responsibility for market studies. In many firms this may be the sales department, and in others it may be a particular staff which specializes in this area. Regardless of the organization plan, the sales manager should participate actively in the development of the sales budget, since he will be the individual primarily responsible for the execution of the sales plan. This general procedure is equally applicable to every other segment of the business and should be vigorously pursued.

Considerable frustration will be generated if an **operating foreman** has laid before him certain objectives to be accomplished when he is not in sympathy with the program and has not had an opportunity to participate in its development. Furthermore it is unlikely that maximum results can be achieved without substantial understanding of the program by those charged with its execution.

In this connection Francis (Controller, vol. 22) points out that:

> Budgets are frequently developed by one or two key individuals in the accounting section of the company. Sometimes these estimates are submitted to top management without the prior knowledge or approval of the operating executives in the sales, advertising, manufacturing, or purchasing departments. This is the worst type of budget procedure and quickly defeats the objectives of forward planning.

Woodhead (Controller, vol. 23) emphasizes the importance of the foreman's understanding the budget, standard, or objective used to measure department cost performance: "Don't let the budget remain a mystery guarded carefully among the ledgers and charts in the accounting department. In fact as your program matures and the foreman becomes more and more familiar with its operation and objectives give him an equal voice in the establishment of budgets."

Plan or Forecast	Department Preparing
Sales (orders and shipments)	Sales—Accounting
Inventories	
Finished goods	Sales—Production—Accounting
Work in process	Production—Accounting
Raw materials	Purchasing—Accounting
Production requirements—units	Production
Direct labor requirements	Production—Personnel
Direct materials requirements	Production
Indirect manufacturing expenses	Production—Purchasing—Personnel—Accounting
Nonfactory departments' expenditures	Respective Department Heads—Accounting
Executive division	
General office	
Accounting	
Purchasing	
Industrial relations	
Sales	
Others	
Capital improvements	Engineering—Production—Sales, and others
Cost of goods manufactured	Accounting
Cost of sales	Accounting
Other income and expenses	Accounting
Prepaid expenses and accruals	Accounting
Purchases	Purchasing
Accounts payable	Accounting
Loans payable	Treasury
Payroll	Accounting
Accounts receivable	Treasury
Cash	Treasury
Profit and loss	Accounting
Balance sheet	Accounting

Fig. 1. Budget plans and departments preparing them.

The development of budgets at the departmental level does not imply to any degree that the budget committee must accept, without revision, these preliminary budgets. It is the responsibility of the budget committee to review the several **departmental budgets** and weld them into a unified whole; therefore, adjustments will doubtless be required. On the other hand, departmental supervisors are often best-equipped for formulating initial budgets, and accordingly they should be given the responsibility for this task.

BUDGET MANUAL. A manual should be developed which sets forth the objectives of the business, the part which a budget plays in the accomplishment of these objectives, the specific procedures to be followed in the development of the

	Sales	Finished goods inventory	Work in process inventory	Raw materials inventory	Production requirements—units	Direct labor requirements	Direct material requirements	Indirect manufacturing expenses	Nonfactory departments expenses	Capital improvements	Cost of goods manufactured	Cost of sales	Other income and expenses	Prepaid expenses and accruals	Purchases	Accounts payable	Loans payable	Payroll	Accounts receivable	Cash	Profit and loss statements	Balance sheet
Sales					X							X							X		X	
Finished goods inventory					X						X	X										X
Work in process inventory					X																	X
Raw materials inventory					X		X															X
Production requirements—units	X	X	X	X		X	X	X			X											
Direct labor requirements					X													X				
Direct material requirements				X	X										X	X						
Indirect manufacturing expenses					X									X		X		X			X	
Nonfactory departments expenses														X		X		X			X	
Capital improvements																X		X				X
Cost of goods manufactured		X			X																	
Cost of sales	X	X																			X	
Other income and expenses														X		X	X		X	X	X	
Prepaid expenses and accruals								X	X				X				X			X		X
Purchases							X									X						
Accounts payable							X	X	X	X			X		X					X		X
Loans payable													X	X						X	X	X
Payroll						X		X	X	X										X		X
Accounts receivable	X												X							X		X
Cash													X	X		X	X	X	X			X
Profit and loss statements	X							X	X			X	X				X					X
Balance sheet		X	X	X						X				X		X	X	X	X	X	X	

Fig 2 Relationship of budget schedules

budget, and the reports of budget information and actual operating data to be utilized. A budget manual should also give such additional information as the functions of the budget committee and budget director and their relationship to the other segments of the business in the development and administration of a budget.

Budget manuals have a number of **advantages**. They serve to define and clarify many matters. Numerous uncertainties may be discovered, and through clarification, a better understanding of the parts and of the whole may evolve. **Periods of training** may be reduced when oral instructions are supplemented with written procedures. Further, less embarrassment may occur if answers to questions can be obtained from a manual. Reliance on memory is eliminated when a procedure is reduced to writing. Furthermore, unless procedures have been reviewed and written down, it is likely that the turnover of employees and passage of time may contribute to the changing of procedures without the knowledge or consent of superiors.

Recognizing that budget manuals vary a great deal in form and nature, depending upon the size and nature of the company and the comprehensiveness of its budgetary procedure, Heiser (Budgeting—Principles and Practice) states that in general the **contents** of the budget manual should include:

1. A statement of purpose and principles.
2. Definition of lines of authority and responsibility.
3. Statement of duties of various personnel in preparing the budget.
4. Time schedules for budget preparation.
5. Forms of schedules.
6. Procedures for obtaining approval
7. Form and nature of performance report.
8. Procedures of budgetary control.

White and Dysart (NAA Bulletin, vol. 38) emphasize the importance of a budget manual for use by operating department heads, and include the following sections in their budget manual for a company:

1. Value of a budget.
2. Departmental functions.
3. Function of the financial control division.
4. Budget process.
5. Expense budget changes
6. Aids to better budgeting.
7. Sources of expense.

As a general proposition, the budget manual should be prepared in rough draft form by the budget department, supervised by the budget director. This draft should be circulated to all concerned for study and suggested changes The final draft will be developed after proper consideration has been given to these remarks and attempts have been made to reconcile conflicting ideas. After preparation the manual should be distributed to all persons concerned with the development and use of the budget. The Controllership Foundation study by Sord and Welsch (Business Budgeting) showed that approximately half of the companies in the survey which have budget programs have a budget manual or its equivalent.

EFFECTIVE UTILIZATION OF BUDGETS. The chief value of a budget as a control device will be realized through effective use of reports. (See material under "Reporting" in this section.) As pointed out by Lawrence (Cost Accounting, revised by Ruswinckel): "Control is exercised through comparison of

actual with budgetary figures to learn where, how, and why accomplishment is not equaling the achievement called for by the budget and to assist in determining whatever corrective measures should be taken." For this reason, reports should be kept simple, readable, understandable, and free of irrelevant information. They should always be designed with the users in mind. As pointed out by Heiser (Budgeting—Principles and Practice), the reports are almost universally made by the controller's division, even where there is a separate budget director's organization, because the necessary data must be obtained from the accounting records. In this connection, the budget director and the accounting staff in most companies are not directly responsible for **cost control** and **cost reduction**. The actions necessary to control and reduce costs must be taken by line executives and supervisors.

REVISION OF BUDGETS. Business budgets should not be regarded as fixed and unchanging but rather as guides to assist management in the conduct of its operations. As such, it will be necessary to revise budgets from time to time as conditions warrant. The National Association of Accountants found in one of its surveys, Research Series No 18 (NAA Bulletin, vol. 31) that, "most of the companies interviewed revise their master budgets when important changes in volume or other conditions occur." The study also indicated that various criteria were used in determining the **frequency of revision**, but that ". . . most companies believe twelve-month forecasts of volume can be used as the basis for over-all planning, but that from one to four months is as far ahead as estimates can be made with sufficient certainty for production scheduling and cost control purposes."

Not all firms, however, advocate budget revision during the time period covered by the budget. Probst (NAA Bulletin, vol. 38) writes that as a matter of policy at the Carrier Corporation: "Budget figures as set up at the beginning of the year should remain firm. They should not be revised. Instead, reliance on the variations between actual and budget figures should be utilized to locate the points at which the company is veering from the predetermined course."

Production Budget

BASIS FOR OTHER BUDGETS. A budgetary system will probably be most effective in the accomplishment of management's objectives when plans are coordinated through a series of budgets developed for each function of the enterprise.

The production budget is the first of a series of manufacturing budgets which will be prepared in this over-all program, and the data contained in it will be the basis for the preparation of the materials budget (see section on Materials) and the labor budget (see section on Labor Costs). Furthermore, it is a prerequisite to the conversion of the overhead budget to the projected level of operations. (See section on Manufacturing Overhead and Normal Activity.) These budgets, with others described in the Accountants' Handbook (Wixon, ed.), are essential in the preparation of a **forecast income statement** and **balance sheet**.

DEFINITION. The production budget is usually based on the **sales budget** and the **desired inventory levels**. It is an estimate by time periods of the production volume as required by the preceding two elements. According to the Controllership Foundation study by Sord and Welsch (Business Budgeting) approximately 85 percent of the manufacturing companies included in the survey

developed **production budgets,** compared with the 99 percent that developed **sales budgets.**

Blocker and Weltmer (Cost Accounting) point out that production budgets deal with:

1. The determination of the total estimated volume of production.
2. The division of the estimated output into classes or types of products.
3. The scheduling of operations by days, weeks, and months.
4. The establishment of finished goods inventory requirements.
5. The storage of finished products until delivery can be made in accordance with sales orders.

OBJECTIVES. The purposes of a production budget are to make provision for the following:

1. **Production planning** by answering such questions as:
   a. What shall be produced?
   b. When shall it be produced?
   c. In what quantities shall it be produced?
2. Reviewing the **productive capacity** for meeting the production planned and for planning any additions or betterments for inclusion in the plant and equipment budget.
3. Scheduling **labor requirements.**
4. Scheduling **material requirements** and a **purchase program.**

The production budget also permits the preparation of schedules showing **cost of production, cost of sales,** and **cash requirements.** The cost of production is essential in the computation of cost of sales, an important figure on the income statement. Furthermore it will be helpful in appraising the profitability of various products included in the line.

A production budget requires the formulation of certain policies out of which will accrue a number of **advantages:**

1. Plans can be made to keep inventories at reasonable levels consistent with production and sales requirements. This will tend to minimize obsolescence and mark-downs.
2. Raw materials requirements can be determined and sources of supply selected so as to get the best quality materials at the lowest price, shipped economically.
3. Attention is focused on producing goods according to a certain time schedule. This will aid in having goods available for customers at the right time in the right quantities.

Although considerable progress has been made in many phases of scientific management, instances of excessive inventories and shortages of materials and finished products continue to crop up. The sales volume of a firm is often greatly influenced by factors beyond the control of the company. Careful planning through a production budget will help management in its efforts to control inventories, to order in **economical lot quantities,** and to recruit, maintain, and utilize its labor force effectively.

BUDGETING PROCEDURE. Heckert and Willson (Business Budgeting and Control) list the following **steps in budgeting production:**

1. Determine the period of time to be used as a basis for the production budget.
2. Ascertain what physical quantities should be produced to meet the sales budget and to provide properly balanced inventories.
3. Determine when the goods should be produced.
4. Determine where the goods should be produced.

5. Determine the manufacturing operations required by the production.
6. Establish standards of production performance for use in measuring production efficiency.
7. Develop a program of materials, labor, service, and equipment requirements.
8. Establish production cost standards.
9. Translate the production program into standard or estimated cost to effect financial coordination.
10. Use the production budget for purposes of cost control.
11. Make necessary revisions of the production budget.

Steps 6, 8, and 9 involve the use of **standards** which doubtless will aid in the control function of management, but it is possible to develop useful production budgets without the establishment of standards.

SALES AND INVENTORY REQUIREMENTS. Sales executives are not always cognizant of the fact that the sales program can produce an unbalanced production schedule. The sales manager may emphasize volume and overlook balance. In his desire for new products and their substitution for present products which the company has the equipment to produce, he may tend to emphasize the development and manufacture of products which will result in the underutilization of present equipment. Thus a study of **productive capacity** and its relation to the sales budget becomes a matter of considerable importance.

Such a study may also be helpful in locating bottlenecks. No plant can have a productive capacity in excess of that of the department or process which has the least capacity, unless the products of a particular department have a market in their own right, exclusive of the additional processing normally given. Over-all capacity in a plant is determined by the least productive department, and the production output of other departments is dependent upon its manufacturing volume. When a **sales budget** calls for production in excess of the capacity of the least productive department, consideration must be given to securing additional capacity in order to provide a better balance with productive capacities of other departments. (For a detailed discussion of plant capacities, see section on Manufacturing Overhead and Normal Activity.)

When the policy of **minimum inventories** has been established, it is essential to have a proper balance of each type of product in the inventory at all times. Accordingly, a calculation of planned production is made for each product or line of products individually, and the results are combined to give a **total production forecast.** Heiser (Budgeting—Principles and Practice) illustrates in Fig. 3 the preliminary computation of required monthly completions for one quarter. The desired inventories at March 31 are based on the sales estimates for April, one month beyond the current budget period, which must be made for this purpose.

PRODUCTION SCHEDULING. In scheduling production, it is important to note the distinction between **job-order production** and **stock production.** In a job-order situation it is often impossible to determine in advance the exact kind of product which will be ordered by customers. Blocker and Weltmer (Cost Accounting) point out:

> This inability to estimate customer requirements forces the management to confine the production budget to general production plans in the form of estimated direct labor hours, machine hours, or estimated units of each general type of product, although in some cases an analysis of past sales can be made in order to ascertain the elements and operations which are common to all contracts.

To the extent that orders can be obtained well in advance of manufacturing and delivery dates, it will be possible to engage in some production scheduling.

	Month's Shipments	Desired Inventory at End of Month	Total Required	Inventory at First of Month	Required Completions
Product A					
Jan	2,000	3,000	5,000	1,000	4,000
Feb.	3,000	7,000	10,000	3,000	7,000
Mar.	7,000	7,000	14,000	7,000	7,000
Total					18,000
Product B					
Jan.	2,000	2,000	4,000	3,000	1,000
Feb.	2,000	2,000	4,000	2,000	2,000
Mar.	2,000	3,000	5,000	2,000	3,000
Total					6,000
Product C					
Jan.	8,000	6,000	14,000	6,000	8,000
Feb.	6,000	4,000	10,000	6,000	4,000
Mar.	4,000	3,000	7,000	4,000	3,000
Total					15,000

Fig. 3. Preliminary computation of forecast quarterly production in units of product.

When production is wholly or largely for stock, the production budget can be more specific and give a more detailed analysis according to **product line** than is the case in producing to customers' orders. Preparation of a production budget in such a case involves a study and correlation of three types of information:

1. A sales volume budget based on products or product lines.
2. A determination of the inventories of finished products desired at the end of each month or other selected period.
3. A statement of the productive capacity in terms of departments of operations.

LENGTH OF PRODUCTION PERIOD. In the preparation of the production budget, it will be necessary to determine how long it will take to manufacture each product, so as to be able to schedule production in such a way as to have the quantities of goods on hand ready for delivery as called for in the sales budgets. Obviously, if more than one plant is involved, the manufacturing facilities and areas served by each plant, as well as **time schedules** for each product, must be considered.

Different lengths of time will be required to manufacture different products. Sometimes a product will require several weeks or several months to start and finish. Hence, if 1,000 units of product are expected to be required at a certain time and the processing time is three months, it will be necessary to schedule manufacture to begin on these units at least three months prior to expected delivery date. Not only will it be necessary to take into account the fabrication of the finished goods but also the time period required to manufacture parts entering into the final product.

STABILITY OF PRODUCTION. Rautenstrauch and Villers (Budgetary Control) write that "to stabilize production and yet to adjust it so as to maintain

the inventory at its optimum level is one of the cornerstones of budgetary control." A problem which must be dealt with in scheduling production, therefore, is the **seasonal element** inherent in many businesses. The use of the **natural business year** is advantageous to companies having substantial seasonal sales fluctuations. The principal portion of sales may occur during certain time intervals, whereas during other parts of the year sales may be only nominal. Thus, if production is geared directly to sales deliveries, it may be that a substantial portion of the plant will be idle for certain periods, while working overtime during other periods. Such production schedules may not be economical.

Furthermore the environment in which many businesses operate today is such as to necessitate the consideration of public reaction to certain company policies. The community and work force have a keen interest in **employment stabilization,** and the effects of employment policy on these groups should not be ignored in production planning.

Schroeder (NAA Bulletin, vol. 39) points out that even though sales fluctuate, it is still possible to keep production at fairly constant levels. He lists the following **costs of fluctuating production** not readily apparent from the records:

1. Training new employees is costly.
2. Additional employees mean additional fixed benefits.
3. Interviews, medical examinations, and payroll record-change costs increase.
4. Seasonal turnover decreases morale and productivity of employees.
5. Materials are not purchased so economically as they could be if production were stable.
6. Setup costs increase if production volume is irregular.
7. Obsolescence is a product of idle equipment, and depreciation results from overworked equipment. Both these considerations apply when production is seasonal.
8. Overtime is common when production volume changes sharply upward.
9. Production scheduling, and therefore meeting of delivery promises, becomes difficult.
10. Undependable inventory volume fails to stimulate the sales force.

INVENTORY CONTROL. Stabilization of production with a condition of fluctuating sales must, of course, be accomplished through building up and reducing inventories at appropriate times. The problem of inventory policy and control is indeed a broad and complex one, often complicated by hand-to-mouth buying policies of customers. The advantages of minimum inventories must be weighed against those of stabilized production when the two policies seem to run counter to each other.

Considerations favoring minimum inventories, i.e., production in line with sales requirements, may be enumerated as follows:

1. Minimum investment in inventories.
2. Reduced interest cost when capital is borrowed.
3. Less insurance required on inventories.
4. Less storage space and handling required.
5. Smaller property taxes.
6. Less chance of spoilage and obsolescence.
7. Less risk of price decline and changes in customers' demands.

Considerations favoring building of inventories in slack periods are summarized below:

1. Less labor turnover, with resulting better morale, improved production, and reduced costs of hiring and training.

2. Possible savings in unemployment insurance taxes under merit-rating provisions.
3. Possible elimination of added labor costs of overtime.
4. Less productive capacity required through leveling of production peak, thus decreasing fixed charges and unabsorbed overhead.
5. Better balanced utilization of staff and better trained staff possible.
6. Production in most economical size lots possible.
7. More efficient equipment, labor, and supervision can be utilized.

The extent to which each of these considerations is of importance depends upon the following factors:

1. Adequacy of funds for financing inventory accumulations.
2. Whether the product is staple or subject to style changes and customers' whims.
3. Productive capacity available at the time the question arises
4. Proportion of skilled to unskilled labor and the local supply of each.
5. Tendency toward wide fluctuations in the price of raw materials and finished goods.
6. Relative importance of setup costs in relation to operating costs.

Bechtel (NAA Bulletin, vol. 36) makes the following pertinent comments about the **inventory problem**:

We see—again and again—many individual businesses and many industries forced to unload excess goods on a falling market. Always produced during a period of high business activity, excess inventories usually represent high-cost raw materials, high labor costs due to overtime and the less efficient efforts of labor when jobs are plentiful. Also, quality is often relatively poor, since customers have to accept whatever is available when goods are scarce, and production is pushed without adequate time to exercise close quality control. In the reverse situation, inventories are usually insufficient to meet an upsurge in business which eventually gets underway. Filling orders is delayed until labor forces are built up and trained, sales losses occur, and we lose the appreciation in value on the upswing in costs. Stable production and steady jobs for plant and other personnel are difficult to maintain.

CHANGES IN WORK-IN-PROCESS INVENTORIES. The production budget must be modified to give consideration to changes in the volume of work-in-process at the end of each month. When the policy is to keep **finished goods inventory** at a minimum and related to sales demand, an increase in sales must be anticipated by increasing the work in process. The average **length of the production cycle** indicates how far in advance of an increase in sales the increase in production must be planned. Similarly, a reduction of work in process must precede a forecasted drop in sales. It should be noted that production must be accelerated faster than sales on the upturn and decelerated faster than the decline in sales on the downgrade, if the policy of keeping inventories in direct relation to sales is to be followed. This is true because an increase in sales requires added production, both to meet the increased sales and to keep the inventory in the desired relation to sales. This is one of the undesirable features of attempting to maintain a fixed rate of inventory turnover for all rates of sales activity.

ADEQUACY OF FACILITIES. Production ordinarily should be scheduled within the limitations of both storage and manufacturing facilities. **Storage** may be costly, and except in unusual situations, inventory quantities should not be permitted to become so large as to require temporary additional facilities. The absence of proper storage areas may result in rapid deterioration of inventories. Additionally, **obsolescence risk** is greater with exceptionally large inventories.

A firm's production is limited, among other factors, by its manufacturing facilities. It is therefore important that the product be scheduled on equipment as economically as possible. In general there should be sufficient facilities to produce the planned volume and enough additional capacity to meet peak loads. Careful consideration must be given to planning production so as to avoid bottlenecks, whenever possible, and at the same time to utilizing the equipment as fully and as effectively as possible. Planning should entail a study of **idle capacity** and a scheduling of production so as to minimize it.

To the extent possible, plans should be made in advance concerning particular equipment to which certain size orders should be assigned for manufacture. For example, assume that Type A and Type B machines have been designed to produce the same product but that Type A is less automatic than Type B and requires somewhat more labor to operate. Pertinent costs are as follows:

	Type A	Type B
Setup costs	$40	$60
Variable costs per 100 units	49	44

Under this cost structure, orders for less than 400 units should be processed on Type A machine, and orders for more than 400 units should be processed on Type B. For an order of 400 units, it is a matter of indifference whether the job is assigned to Type A or Type B machine. These answers have been determined as follows: Let X = cross-over units; then

$$49X + 40 = 44X + 60$$
$$X = 4$$

that is, 400, since unit costs were expressed in dollars per hundred units.

The study of manufacturing facilities in production planning is closely related to the **plant and equipment budget** (see the Accountants' Handbook, Wixon, ed.). Inadequacies of manufacturing facilities will be revealed in the development of the production budget, and it is in the plant and equipment budget that the expansion of facilities will be formalized.

AVAILABILITY OF RAW MATERIALS AND LABOR. Production planning will be affected by the availability of both raw materials and labor. From time to time, shortages of materials may develop, and this obviously will have an impact on production scheduling. During World War II, nylon was rationed to commercial users. As a result, production of nylon-content goods for nonwar consumption was directly geared to the time intervals when nylon yarn could be obtained for these purposes. Labor strikes among employees of raw materials suppliers and transportation companies can seriously affect delivery dates of such materials. The training time and supply of skilled workers can also be an important consideration in the development of a production budget. These factors must receive appropriate attention in the planning of production.

RELATIONSHIP TO OTHER BUDGETS. The production budget lays a foundation for the development of a comprehensive budgeting program. It provides a basis for coordinating the sales and production programs and facilitates the planning of capital additions and cash needs. It is a vital link in the preparation of **financial statements** on a forecast basis and is indeed basic to factory budgeting in general.

ESTIMATED COST STATEMENTS. After the decision has been made on the physical quantities to be produced, the materials, labor, and manufacturing

overhead requirements will be determined and the **cost of production** computed. When the sales and production budgets have been drawn up, the estimated amount of finished goods inventories will be known, and the **cost of goods sold budget** can be prepared.

Human Reactions to Standards and Controls

CONTROL THROUGH PEOPLE. Cost control is a function of management and must be exercised by and through people. None of the devices which have been developed to aid management in the control of operations will be effective unless it is utilized by people. The success of a control system depends on how the **control devices** are viewed by those who are expected to administer them and who have their performance measured by them.

The Human Element. The objectives of a firm are such that their continued successful realization is dependent upon how well each member of the firm carries out his assigned task and upon the integration of these accomplishments toward the central objectives. Any **control system** has as its objective the increased efficiency of operations, which in turn implies increased productivity. The control system, then, is a means to an end. If the end result is not accomplished, the program will be a failure.

Unless the control system includes means for providing information useful in controlling costs and provides an environment which facilitates the intelligent use of the information, a firm is losing the chief potential benefits of its system. The **technical aspects of control** entail the determination of what the costs should be, a comparison of actual results with planned results, and follow-up of the significant deviations by corrective action. These steps in the control process, however, must be administered by many different people and perhaps in many different ways. A lack of sympathetic understanding and support of the control system by those responsible for it will often render ineffective the most elaborate and technically sound control programs. Copell (Manufacturing Series No. 207, American Management Association) points out that "attaining this objective of increased productivity is perhaps a human problem even more than a materials or an engineering problem."

Attention to the human element in the control process is a rather new development in **scientific management.** It was only logical that attention should first be focused on the development of technical tools as an aid to management in controlling costs. Development of these tools and an understanding of how they could be used to control operations almost necessarily had to precede their application to specific control problems. As firms became larger, more and more authority was delegated, and operations became more decentralized. The success of the control system came to depend to a greater extent upon the human feelings, attitudes, and reactions generated by the control procedures and by the way in which they were used.

Cost Consciousness and Motivation. The coordination and utilization of human effort may be looked upon as the core problem of management. Hood (Manufacturing Series No. 221, American Management Association) reports that in the Ansul Chemical Company, the problem of cost reduction was diagnosed "as a problem of people's attitudes more than a problem of things. We determined that if we could motivate people, change their attitudes, and create in them a concern for cost, the resulting effect would be cost reduction."

Thus it is important that **cost-conscious attitudes** be developed in top management, through departmental supervisors, and down to the people on the production line. These attitudes must become part of the individual's general work approach if costs are going to be successfully controlled at the point where they are incurred. They must have a spontaneity which is immediately exhibited when action is needed.

It is for these reasons that the study of **human relations** has become important in the administration of standards and controls. Cost-consciousness can be developed only through the most painstaking study and through education. Glover and Roethlisberger (Controllership in Modern Management, Bradshaw and Hull, eds.) point out in this connection:

> The human problems involved in the installation, development, and management use of standards and control systems require at least as much attention as do the engineering, accounting, statistical, analytical, and other technical problems. Indeed, the human misunderstanding and resistances which can be generated unwittingly through the use of these tools of management can often nullify the benefits expected to be gained from them.

Peirce (Harvard Business Review, vol. 32), speaking of one of the widely used instruments of control, writes: "Budgeting rests on principles which have more in common with concepts of human relationship than with rules of accounting. . . ."

The invisible and intangible esprit de corps of an organization doubtlessly influences the productivity of the workers and thus of the firm as a whole. This morale can be undermined if controls are improperly developed, inadequately explained, or incompletely presented to the people who will be charged on the one hand with the responsibility for carrying out the program and on the other with having to explain their performance in terms of the **control standard.** In short, as stated by Dickey (Cost and Management, vol. 31) "cost control is people," and rigorous efforts must be made to solve not only the technical aspects of a control program but also the human problems which are inherent in its administration.

Viteles (Motivation and Morale in Industry) summarizes the importance of **worker motivation** as follows:

> The disregard of a worker's capacity to feel, think, and grow is a subtle but menacing danger in breaking down his social and spiritual morale. To increase productivity, heighten job satisfaction, and raise the level of employee morale, it is necessary to arouse the intelligent interest of the employee. It is urgent to enlist his feelings as well as his abilities in his work. The failure to do so will, at best, produce an ineffective worker. At worst, it will transform the worker into an industrial rebel.

THE HUMAN RELATIONS PROBLEM. In all human activity there are certain norms which condition responses to various stimuli. These **norms,** which affect the thinking of each individual, exist in business activities as well as in other spheres of human endeavor. The problem of human relations in modern business is one which involves an understanding of these norms, coordinating productive effort within their framework to achieve certain objectives, and if necessary changing them in whole or in part through education.

Group standards usually reflect what should or should not be done in particular situations. Furthermore they exert strong control over the behavior of individuals. Thus reactions to the orders, requests, and suggestions of the "boss" will to some degree be influenced by the complex network of norms prevailing within the group to which the individual "belongs."

Basic to a solution of the general problem is a feeling that business executives should not be arbitrary in their actions with employees. Much evidence has been accumulated which points to the desirability, if indeed not the necessity, for making available to employees accurate information concerning such things as wage policy, grievance procedures, and company operations and finances. These are doubtlessly included in the norms which have been developed within some business groups. Such factors must be given appropriate recognition in the consideration of the group effort if maximum results are to be achieved.

The development of **mutual respect** by both administrator and employee for the individual and the role he fills is sometimes difficult but very important. Bosses must boss and subordinates must be subordinate, but these relationships will usually be more productive if they do not result in attitudes of superiority and inferiority.

Reactions of people influence every sphere of human activity, including the area of cost control; therefore a human relations problem does exist, and it is very real, even though intangible. The first step in the implementation of a cost control program should be the recognition that its success will depend in large part upon the reactions of those people who have primary responsibility for the incurrence of costs. Recognition of this fact must precede development of methods and ways by which the program can be successfully administered.

In summarizing the Controllership Foundation study of management planning and control practices in 424 companies (Business Budgeting), Sord and Welsch listed "the more important characteristics of successful budgeting which clearly stand out in the composite picture." It seems significant that of the 20 characteristics listed, six were in the area of human relations. These emphasized: "active support and participation in the budgetary program from top management to the lowest level of the supervision," "adequate recognition of and emphasis on the importance of enlightened human relations in generating a spirit of willing cooperation among persons associated in an enterprise" and "a system of budgeting designed and applied primarily to motivate people rather than to exert pressure on individuals."

OPPOSITION TO CONTROLS. One of the basic human problems in the administration of a control program is the almost universal **dislike for controls** and **resistance to change.** Unfortunately the feeling seems to have developed on the part of many employees that a control system is used principally to exert pressure, which in turn may result in occupation and method changes and in some cases outright dismissals. Such actions on the part of management are indeed by-products of a control system, but it should be emphasized that the objective of the program is to increase efficiency and to provide a sound basis for constructive planning for cost reduction.

Argyris (The Impact of Budgets on People) states in a pilot study by the Controllership Foundation that both production supervisors and budget administrators found considerable fault with each other in the use of budgets. In this same study, Argyris summarized the **impact of budgets on people** as follows:

1. First, budget pressure tends to unite the employees against management and tends to place the factory supervisor under tension.
2. Second, the finance staff can obtain feelings of success only by finding fault with factory people.
3. Third, the use of budgets as "needlers" by top management tends to make factory supervision see only the problems of their own department. The supervisors are not concerned with the problems of other personnel.

4. Finally, supervisors use budgets as a way of expressing their own patterns of leadership. When these patterns result in people getting hurt, the budget, in itself a neutral thing, often gets blamed.

Other evidence points to the existence of human opposition to controls, very often with genuine reason. Glover and Roethlisberger (Controllership in Modern Management) take the position: "Certainly, it is not just happenstance or the inbred defects or 'orneriness' of people down the line which accounts for the fact that words like 'standards,' 'budgets,' and 'quotas' conjure up mental images of men in front of the boss producing alibis and defenses, while the boss demands explanations and improvements."

POLICIES TO FACILITATE CONTROL. Certain general policies can be formulated which, if pursued vigorously, can have a healthy effect on the use of budgets and standards as control devices. Not all these policies may be necessary in every situation; nevertheless their adoption can hardly fail to increase the effectiveness of a cost control or reduction program.

High Morale. An organization is unlikely to continue to operate at a profit even with the existence of high monetary rewards for employees, without the rather subtle and intangible factor of morale. A business cannot be regarded simply as an agency for making profits. It must be viewed in its total perspective, which certainly includes the people who serve it. The **rewards for work** must include not only economic incentives but also those which stem from participation, from doing a good job, from belonging. These are characteristics of morale, a necessary ingredient of efficient performance.

Results of high morale are difficult to measure in dollars and cents, yet the effects of good or poor morale are very real and contribute significantly to the success or failure of a cost control or cost reduction program. Dickey (Cost and Management, vol. 31) takes cognizance of this fact when he says:

> The way in which control devices are administered has an important influence on morale. The esprit de corps of the organization can be seriously undermined if the human problems involved in the building and administration of budgets and standard costs and other control devices are handled poorly. It appears that this has often happened.

Management Support. Any action which is to be carried out successfully in a business firm must be supported vigorously by management. This is a factor which must be given high priority. Mere lip service to a program will not suffice.

It is management's important responsibility to plan and coordinate the efforts of its greatest assets—people. But this responsibility includes **successful leadership**, which in a very large measure is determined by example. Few things can be as frustrating to an employee as a dictum passed down by one whose attitude clearly shows his nonchalance and lack of enthusiasm.

Attainable Goals. In establishing the bases to be used in measuring performance, whether it be **sales quotas or cost allowances,** attention should be directed to attainable goals. This does not mean goals which are necessarily easy to reach but rather those which can be attained with vigorous pursuit. It is characteristic of human behavior to rebel against objectives impossible of attainment. It is equally true that many people readily accept challenges involving actions which they consider difficult, if it appears possible such actions can be successfully completed. People naturally take great pride in accomplishing an especially difficult task.

Understanding. One of the difficulties often encountered in obtaining the co-operation of employees in the administration of a budgetary program is the apparent lack of understanding of the **objectives and uses of budgets.** Few persons are likely to carry out an assigned task with ardor and zeal unless there is an appreciation of how the individual parts fit into the whole. Such an appreciation depends upon understanding.

Time should be made available in the form of **individual or group conferences** for explaining the objectives and uses of budgets and standard cost systems, how they will be administered, the extent of flexibility, and the way in which they will be used in appraising performance of employees. So important does Peirce (Harvard Business Review, vol. 32) view this factor that he writes:

> It should be evident that the effect of control on people is commensurate with their training and conditioning for it. If they understand thoroughly the meaning and uses of control, they will view it in the light of common sense They will neither resent it nor be awed by it. They will turn it to the constructive use for which it is intended, and it will become an aid rather than an obstacle.

Participation. It is generally conceded that a fundamental characteristic of a successful **human relations program** in industry is the availability to employees of an opportunity to make suggestions regarding all phases of their work life. This is especially true regarding the **development of budgets and standards,** devices which they will have to administer and be measured by.

It may be that no one in the organization knows as much about a particular job as the individual performing that job. It, therefore, seems advisable that those who will be charged with the responsibility for cost incurrence should be given ample opportunity to express their opinions. More enthusiastic support for these control devices can be expected if employees contribute to the establishment of the goals. As stated by Holman (NAA Bulletin, vol. 40): "A man will go out of his way to make a plan work if he feels that it is his own creation rather than something that has been forced upon him. He can often find ways and means of effecting savings that the 'front office' would never dream of."

Heiser (Budgeting—Principles and Practice) emphasizes that:

> One point on which there is fairly general agreement is that the most effective cost control under a budgetary system occurs where the foreman or supervisor has a voice in the determination of his expense budget schedules. It is common practice to secure beforehand his approval of the flexible expense schedules. This serves to ensure his confidence in the control system whereby his performance in the control of expenses is to be measured.

Sord and Welsch, in the Controllership Foundation study of planning and budgeting in 424 companies (Business Budgeting), refer a number of times to the importance of participation, which they describe as "one of the fundamentals of good human relations":

> Executives interviewed repeatedly stressed the importance of, and attention given to, active participation in setting standards by those responsible for performance. One of the principal reasons given is that such participation helps to promote understanding of the standards and of how they were set. It also helps to gain acceptance of such standards by the people who must achieve them. A third reason for desiring such participation is that it tends to create a clearer understanding of responsibilities for performance. A fourth reason cited is that the practice is conducive to better relations beween line and staff personnel.

Good communication is an important factor in human relations. This is discussed in this section under "Reporting."

Pressure with Budgets. Sometimes budgets and standard costs have been "sold" by emphasizing their constructive uses, but somewhere along the line they often have seemed to become almost wholly pressure instruments. To the extent that this occurs, it will have an unhealthy effect on the attitudes toward the control instrument.

Efforts should be made to satisfy that human emotion which requires recognition for a good job. If the budget is used only as an **oppressive tool,** and comment is made to the employee only when performance falls below the budget, an unnecessary obstacle to administration of the cost control program will be created. Human nature requires a nod of approval on occasion. In short, budgets should be used constructively with as little pressure as possible consistent with the accomplishment of the objectives.

Occasionally top management may become oversold on the accuracy and value of control devices. This condition may result in excessive pressure on middle and lower management. The budget officer therefore has a responsibility to inform top management about **budget limitations** and to strive to see that they are neither misinterpreted nor misused by this group.

Rules of Reasonableness. Budgets and other control devices should be administered fairly and reasonably. In view of the limitations of control tools, care must be exercised in appraising the performance of individuals Common sense must not be permitted to take a back seat in the administration of instruments of control. **Flexibility** should be a continuing objective. Esposito (NAA Bulletin, vol. 35) points out: "It must be recognized . . . that controlling costs in accordance with budget standards requires a good deal of tact and diplomacy. If you put hard-working men on the spot to explain deviations which are unavoidable, you will only cause hard feelings which will result in resistance to the budget idea.'

Dual Responsibility. Production people themselves must take some responsibility by trying to improve their performance and by helping their firm produce as efficiently as possible. Perhaps the primary responsibility for striving to avoid adverse reactions to a control program does lie with the administrator. But he cannot do the whole job. Top management must lend help in this area. Furthermore it should be recognized that an understanding of, and appreciation for, any technical field, such as that of control, cannot be attained quickly. Accounting, budgeting, and production personnel must be willing to work together for the greatest good. It is not a one-way street or a one-department job. Nevertheless, as Argyris (Harvard Business Review, vol. 31) says: "Whatever specific steps they [the financial staff] take or new attitudes they adopt because of their better understanding of themselves and others in the organization cannot fail to make their use of budgets more constructive, i.e., more effective in terms of long-run results."

Reporting

MEANING AND PURPOSE OF REPORTS. Reports are communications, usually in written form, of physical or cost facts which should be brought to the attention of management personnel who can use them to take appropriate action. Lewis (Accounting Reports for Management) indicates some of the requisites of a good report and its relation to control:

In a good and effective report, each reported fact is in some way related to the authority vested in a single individual or group of individuals. In other words, the

reported fact relates to a specific action or a related series of actions which are regarded as the responsibility of a specific individual and the organization reporting to him. Not only does the report show the present situation but it also reveals the trend or movement, favorable or unfavorable, over a period of time. By showing the projected future operation, which may be done as an extension of existing trends, the report reveals the potential development of unsatisfactory operations. In this way the need for corrective action is indicated before operations have actually turned seriously out of line. Corrective steps are then taken as a preventive measure This is the essence of control through good reporting.

A well organized **cost accounting system** supplemented by appropriate **cost control techniques** (see "How Control Is Accomplished" in this section) can be of great assistance in cost control at all levels. By coordinating manufacturing activities with sales and purchasing functions and by furnishing supervisors and operators with operating statistics and comparisons of actual costs with budgets or standards, the system gives management prompt, meaningful information enabling it to increase effectiveness and reduce costs. The increasing need for such information is stressed in NAA Research Series No. 28 (NAA Bulletin, vol. 36):

> As an organization grows, management must rely to a greater extent upon information compiled, summarized, and interpreted by the accounting department and other specialized functional groups in the company. Modern techniques for collecting, focusing, and transmitting information to management have had an important place in making possible the efficient operation of large organizations needed to utilize the advances in scientific and engineering knowledge for producing better and less costly products. Even in small companies some systematic plan for collecting and presenting financial information is essential because management cannot personally observe and organize all the facts with respect to sales, costs, and other aspects of a company's operations.

This section is concerned with the general problems of **internal accounting reports.** Descriptions and illustrations of reports pertaining to specific items will be found in that section of the Handbook which covers the subject in question.

TYPICAL COST REPORTS. A system of reports should be tailored to the requirements of each company. A list of reports used by another company, therefore, should not be regarded as a model. It is helpful, however, for a cost accounting department to know what reports are used by other companies, as this may suggest some useful reports that have been overlooked. Fig. 4, compiled by Matz–Curry–Frank (Cost Accounting), shows reports that are now in use in many companies throughout the country.

RELATIONSHIP OF ANALYSIS TO REPORTS. The quality of reporting depends upon the thought and care devoted to analysis. Budgets and standards can be prepared by appropriate **pre-analysis** of physical factors and costs. With **post-analysis** of actual physical and cost performance, useful comparisons can be made in reports designed to localize unfavorable operating conditions, and responsible supervisors can then take timely steps to improve the use of the materials, men, and facilities under their control.

STRUCTURE OF MANAGEMENT NEEDS. Carefully designed cost reports bring significant facts and relationships to the attention of management personnel who might otherwise overlook them. They are essential in any situation where management personnel cannot observe directly all the operations for which they are responsible. To be effective, they must be designed with the different levels and types of responsibility of the individual organization in mind.

Frequency	Name of Report	Sent to	Information Conveyed	Purpose of the Report
Daily	Record of Orders Booked	Sales manager	Sales by major commodities.	To check with sales quotas.
Daily	Summary of Billed Sales	Top management	Dollar value billed to customers.	To compare current figures with corresponding figures last month and last year.
Daily	Idle Time Report	Production manager	Analysis of labor tickets regarding idle time.	To check and control the cost, the causes, and the location of idle time.
Daily	Daily Operating Report	Superintendent	Summary of daily results regarding production, volume, labor, and materials variances.	To control specifications and to measure day-by-day performance.
Daily	Daily Expense Report	Department heads	Comparison of variable overhead with budget.	To control variable expenses.
Daily	Daily Force Report	Department heads	List of the number of men working in each department.	To control allowed number of men according to budget.
Daily	Daily Labor Budget	Foremen, supervisors, division heads	Report on the daily departmental direct and indirect labor cost.	To control labor cost, both direct and indirect.
Daily	Daily Efficiency Report	Superintendent	Presents standard hours, actual hours, and the rate of efficiency.	To assure continuous efficiency and to remedy inefficiencies.
Daily	Daily Plant Report	General manager, executive vice-president	Presents manufacturing expenses for the plant compared with standards	To measure the performance of the various divisions.

Weekly	Bookings and Backlog Report	Sales manager, production planning	Summaries of product lines by product groups, regions, and individual territory levels	To guide sales management into selling according to a schedule matched with plant capacity.
Weekly	Usage and Waste Report	Production manager	Summary of physical quantity of materials used against standard quantity allowed.	To control proper use of materials and to eliminate excessive waste.
Weekly	Direct Labor Report	Production manager	Summary of actual hours vs. standard hours and their respective costs.	To gauge the effect of overtime, of inexperienced labor, of too much time, etc.
Weekly	Departmental Expense Summary	Department supervisors	List of budget allowances against actual expenses with variances.	To control departmental expense.
Monthly	Gross Profit Analysis	Vice-presidents in charge of sales and manufacturing	Statement of gross profit by types of outlet and by-products.	To indicate gross profit contribution of each outlet and product.
Monthly	Analysis of Selling Expenses	Sales manager	Comparison of budget allowances with actual expenses.	To control selling expenses and check variances.
Monthly	Material Price Variance Report	Vice-president in charge of operations Purchasing agent	Comparison of actual materials cost with standard materials price.	To show trend of price movement and purchasing agent's efficiency.
Monthly	Materials Usage Variance Report	Vice-president in charge of operations Superintendent Foremen	Comparison of actual cost with standard cost in dollar values and percentages.	To control actual materials consumption with allowances in standard costs.

Fig. 4. Typical system of managerial reports in manufacturing.

Frequency	Name of Report	Sent to	Information Conveyed	Purpose of the Report
Monthly	Finished Product Damage Report	Vice-president in charge of operations Foremen	Lists value of good production and value of damages, also percentage of total.	To control damages to finished products.
Monthly	Performance Report	Foremen Executive vice-president	States the costs of direct labor and overhead expenses.	To point out efficiencies and deficiencies by departments and types of expenses.
Monthly	Departmental Budget Report	Foremen	Comparison of actual expenses with budgeted allowances.	To control expenses.
Monthly	Production Cost Statement	Divisional superintendent	Summaries of actual cost and standard cost with variances.	To control major elements of cost and to measure effect of volume.
Monthly	Purchasing Report	Purchasing committee	Comparison of actual purchases, consumption, coverage, and inventory figures.	To determine the trend and the result of policies decided upon.
Monthly	Statement of Operations	President	Result of operations of the month with variances listed.	To allow over-all view of results.
Monthly	Sales Analysis	Sales manager	Comparison of quotas with actual sales.	To control salesmen's activities.
Monthly	Returns and Allowances Analysis	Vice-president in charge of operations	List of returns made by customers because of defects.	To show the number and the value of returns by causes.
Monthly	Income Statement	Top management	Results of the month.	To compare actual results with forecast.

Monthly	Balance Sheet	Top management	Results of the month.	To compare actual results with forecast.
Monthly	Surplus Statement	Top management	Results of the month.	To compare actual results with forecast.
Quarterly	Report on Executive Authorization on Capital Expenditures	Top management (executive and operating)	Comparison of estimated savings with realized savings.	To determine whether contemplated savings because of new facilities were realized.
Quarterly	Labor Efficiency Report	Foremen Superintendent	Lists pieceworkers' earnings based on standard hourly rate.	To check upon efficiency rate of production per worker.
Special	Report of Wage Increases	Top management	A study of the effect of wage increases on cost elements and inventories.	To give management a basis for collective bargaining.
Special	Inventory Report	Top management	A study of slow-moving stock.	To reduce inventory cost.
Special	Report on Functions of a Department	Top management	A study of accounting activities carried on in other departments.	To control costs in other departments and to reduce overlapping activities.
Special	Report on Departmental Efficiency	Top management	A study of a department's efficiency, with suggestions for improvement	To reduce costs and to permit greater efficiency.

Fig. 4. (Cont'd.)

If a cost control program is to be effective, it must be participated in by all members of management, and it must be working continuously at all levels of management. In order to develop a **reporting system** which can provide information that will be helpful in achieving both immediate and longer-run cost control, those preparing the data to be used should understand the **management responsibilities** at various levels and how these responsibilities relate to cost control. Carlson (NAA Bulletin, vol. 38) comments on this point:

Reports should be directed to the knowledge, interest, and responsibility of the recipient. A common example of application of this principle, recognizing different levels of interest, is in the reporting of production cost information. The foreman should receive a report pertaining to his department. The plant superintendent should receive a summary of the reports issued to the foremen under his supervision. The vice president in charge of manufacturing should receive a summary of the reports issued to the managers under his direct supervision. At each one of these levels, there are different areas of knowledge, interest, and responsibility. These different levels also require different time schedules of reporting. The foreman is concerned with daily operations. The plant superintendent is interested in weekly performance. The vice president is more concerned with long-term operations in monthly and trend reports.

Tiffany (Accounting Review, vol. 25) identifies the levels of responsibility as top management, coordinating executives, and operating supervisors, and specifies their concerns, including the **measurement of performance** to guide cost control:

Top management should be able to use the principle of exception in reviewing departmental performances. In order to make use of this principle, departmental reports should be summarized by totals only. Management then can discover weak areas in a quick review and can study the details of particular reports where study seems necessary, rather than be forced to review all performances.

While top management primarily is concerned with planning and organization, the execution of plans is the function of **coordinating executives.** They administer policies, direct operating supervisors, and appraise the performance of operating supervisors. The reports which a coordinating executive receives should assist him in administering policies and in appraising the performance of his subordinates.

The level of **direct supervision** is the area of activity in which specific and detailed reporting is required. At the operating level, it is important to analyze and report upon expenditures made and results produced. It is at the operating level where planned performances are tested, where budgets are appraised, and proof is given to proper planning and proper selection of manpower and material.

Operating supervisors, therefore, should receive reports concerning the effectiveness of their operations, and these reports should show planned performance, actual performance, and variations from plans. In order that operating supervisors may be able to use their reports for the control of future operations, it is necessary that the reports give specific information about the department reported on.

FACTORS INVOLVED IN EFFECTIVE COMMUNICATION. Through a properly designed **accounting system,** the accounting department analyzes and collects information about the performance of each individual in the organization, relates that performance to the responsibilities of each individual having management authority, and reports the results to the supervisor concerned, to his immediate superior, and in summary form to interested personnel in top management. This information must be conveyed to the appropriate members of management in such form and at such a time that the recipient can understand and use the information in choosing his course of action. This constitutes effective communication. The basic ingredients of effective communication and sound reports are: an understanding of management needs and the assignment of respon-

sibility; timeliness; content appropriate to the need; and a method of presentation which conveys readily and forcibly.

Management Needs for Reports. In establishing his criteria for a sound structure of **performance-measurement** reports, Neuschel (NAA Bulletin, vol. 38) highlights the requirements for understanding management needs and the assignment of responsibility:

1. It [the structure of reports] conforms to and reflects the company's organization structure so that accountability for results is clearly shown.
2. For each separate organizational unit of the business, it covers all the important controllable elements of performance that affect the group's total contribution to company-wide goals.
3. It represents, in total, an integrated plan of control so that information furnished to all levels of management ties together, simply becoming more condensed as higher levels of management are reached
4. It is, itself, under continuous control so that it can be adjusted promptly to meet changing needs.

Crossman (Accounting Review, vol. 28) states that the alert cost accountant should not necessarily wait for a need to be stated by management. Rather, he should, through his understanding of operations and a study of the information available to him, discover situations which require additional investigation and analysis, for the purpose of controlling and reducing costs.

Timeliness. The team of British accountants who surveyed accounting in American companies reported (Management Accounting, Anglo-American Council on Productivity) that the promptness with which accounting reports were issued was impressive. Many cost control reports are designed to provide immediate correction of unfavorable performance. They must be available as soon as possible after the reported performance in order to minimize losses. They may be scheduled by determining the specific steps necessary to get the data and by estimating the time required by an efficient clerk to assemble the information. As an example, if time cards are prepared daily for each operation in the plant, showing the name of the worker, operation performed, hours worked, and pieces turned out, they may be collected at the end of the day, sorted early the next morning, and then used to provide reports to the section foremen before noon. In this case a worker who needs instruction, or a machine which needs adjustment, gets the requisite service before excessive time has elapsed.

Hanley (NAA Bulletin, vol. 36) makes two points about timeliness:

1. Information to operating management should be available promptly. Such information is "alive" and can be the basis for taking action.
2. The questions of timeliness and accuracy are related. It is certainly better to have information based on some approximations in time to take action than it is to have absolutely accurate information with the same lack of glamor as the news in yesterday's paper.

Speeding Up Issuance of Reports. Considerable attention has been addressed to the problem of issuing various accounting reports at as early a date as possible. A large number of American companies have succeeded in making a worth-while reduction in the number of days elapsing between the close of a fiscal period and the issuance of reports on that period.

A wide variety of techniques have been used, including the following:

1. Reviewing the entire record-keeping system with the aim of making changes to expedite reports.

2. Careful scheduling of specific tasks to avoid bottlenecks.
3. Accumulating certain figures on a daily or weekly basis so that a minimum of work remains to be done at the end of the period.
4. Preparing forms and work sheets in advance.
5. Earlier closings.
6. Using figures estimated by experienced persons with a thorough knowledge of the situation in place of certain actual figures which would not be available until several days later and therefore would delay issuance of a report.
7. Using mechanical, tabulating, or electronic equipment.
8. Using standard costs.
9. Using pre-closing or flash reports based on careful estimates to inform top management of the probable amount of certain key figures before the regular financial reports are available.
10. Careful training of accounting personnel.
11. Using a small amount of overtime in some cases.

At the Seventh International Congress of Accountants, in a discussion on electronic data processing, Phillippe (Journal of Accountancy, vol. 105) expressed perhaps the ultimate in the speeding up of reports when he described his vision of the future when managers would sit in front of television sets and press a button to get the financial position to the very minute. All financial statements would be eliminated except for record purposes.

Content. The cost control information in reports will vary in details from one situation to another in the same firm and from one firm to another, but essentially such information must deal with data about the extent of utilization of materials and supplies, men, equipment, buildings, and certain services. Such utilization can be expressed in physical measurements or physical statistics and the related monetary costs. In order to provide some measure of guidance, **bases for comparison** must be included in the reports. These bases for comparison may be past actual data or budgeted and standard data. The main content of a **cost control report** is:

Physical Statistics About Some Productive Factor	Current Performance Measurements compared with Standard or Budgeted Data in Physical Terms or Past Actual Data

and often

Dollar Cost Data About Some Productive Factor	Current Cost Performance Measurements compared with Standard or Budgeted Cost Data or Past Actual Cost Data

Since operating supervisors understand physical facts quite readily, their reports should be presented primarily in such terms. Summary reports for co-ordinating and general executives should also show the dollar cost effects. The content should be kept simple and limited to data about which the recipient of the report can take action. If the comparisons show significant variations, some comment as to definite or probable **causes of the variations** should be included in order to assist him in taking action. Woodhead (Controller, vol. 23) emphasizes two points about content which improve communication:

1. Be sure the foreman has a thorough understanding of the budget, standard, or objective used to measure departmental cost performance.

2. Keep the information and the reporting form simple. Remember that interpretation and analysis of figures is not usually the primary job of the foreman of a department. It must be readily understood and easily related to the day-to-day operation over which he has supervision. Be sure the information is displayed so it is usable.

Method of Presentation. NAA Research Series No. 28 (NAA Bulletin, vol. 36) outlines the array of **communication media** available in presenting information to management as follows:

1. Written forms of communication.
   a. Formal accounting statements
   b. Tabulated statistics.
   c. Narration and exposition using words.
2. Graphic media.
   a. Charted figures.
   b. Diagrams and pictures.
3. Oral communication.
   a. Group meetings.
   b. Conversation with individuals.

Some selectivity must be exercised in determining the media to be used, since each has its own strengths and weaknesses. NAA Research Series 28 comments that often "a combination of media is more effective than is any single one used by itself." Also, the various individuals to whom control reports are directed differ with respect to their receptiveness and ability to grasp information presented through various media. Pelej (Controller, vol. 27) writes that most talks and published articles on communication between accountants and top management are devoted almost entirely to a discussion of written reports. Pelej says that he is "firmly of the opinion that oral communication is equally important, if not more important, than the written report." Basson (NAA Bulletin, vol. 36), from his experience with a variety of reporting systems, expresses his convictions about method of presentation as follows:

> Accounting jargon should be avoided because many executives are not familiar with accounting technicalities and terms. The effectiveness of charts and graphs should be utilized. This type of presentation can sometimes clearly demonstrate relationships that it would take pages to describe. No one likes to read several pages of description and pore over columns of figures to get information which would be apparent from a moment's look at a chart. A number of the larger companies have adopted presentation by charts as a standard part of their reporting methods. The use of large wall charts, presented to groups, affords an opportunity for direct oral presentation by persons who prepared the charts. This technique is frequently much more effective than merely presenting written material for review.

REPORT TRENDS. NAA Research Series No. 28 (NAA Bulletin, vol. 36) describes reporting practices observed in 30 leading companies and notes the trends. These may be summarized as follows:

1. To reduce the figures presented to management (particularly top management) to a minimum consistent with the needs of the individual recipient. The principal techniques to accomplish this are:
   a. Begin each report with a summary.
   b. Concentrate attention on the items requiring action.
   c. Reduce the number of figures or digits to be remembered or compared.
   d. Use a variety of devices to emphasize significant points.
2. To produce reports in clear, attractive, and easily readable form. A variety of techniques are used to achieve this, including avoidance of closely packed masses

of figures, use of color in the reports, and standardizing terminology, arrangement of report contents, and format of reports.

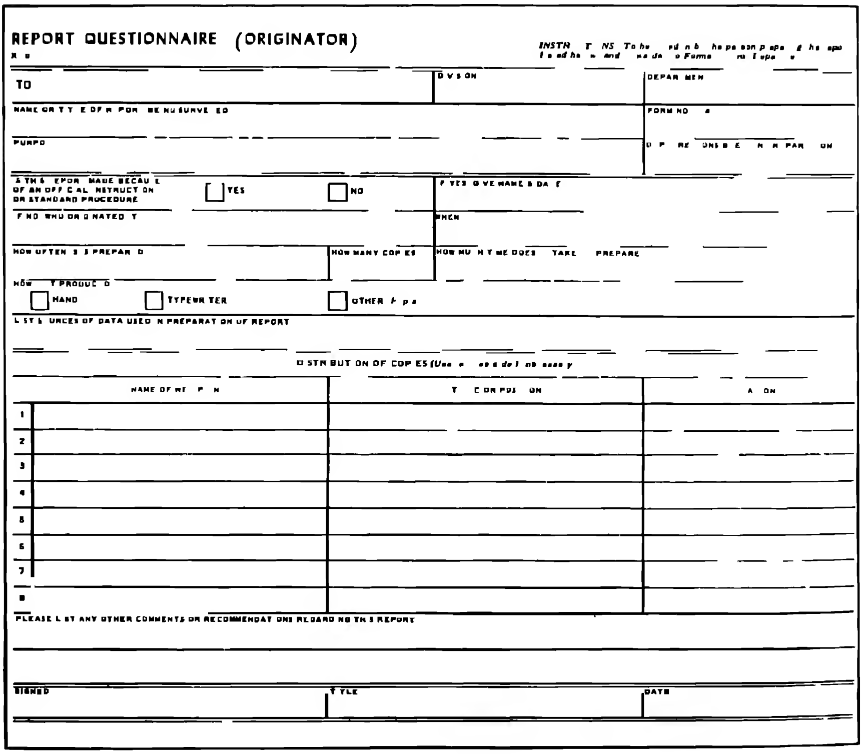
3. To stress timeliness of information, particularly where the figures measure current performance or indicate a need for current action. (Techniques to attain timeliness are discussed in this section under "Speeding Up Issuance of Reports.")

4. To accept responsibility for the analysis and interpretation of accounting figures by including in accounting reports the comments designed to bring out the significance of the figures to the recipients of the reports. The analysis and interpretation of the figures contained in accounting reports is generally viewed as a staff function rather than as a task to be performed by the recipient of the report. The analysis is frequently in the form of a letter or written comments on or accompanying the report. Some companies use oral explanation at committee meetings or at conferences with individual executives in place of or in addition to written comments.

5. To utilize as far as possible terminology and language which is familiar to the recipients of reports and to avoid technical accounting terms when nontechnical terms can be used to convey the same meaning.

6. To use a variety of communication media to increase the effectiveness of the presentation and to improve management's overall understanding of the information presented. (This is discussed in this section under "Method of Presentation.")

REPORTS CONTROL PROGRAM. A corollary to the reduction of the number of figures in a report is the **reduction of the number of reports** themselves. Too many reports are issued in some companies. The use of various mechanical means, particularly electronic data computers, [illegible]


REPORT QUESTIONNAIRE (ORIGINATOR)
TO | DIVISION | DEPARTMENT
NAME OR TITLE OF REPORT | FORM NO.
PURPOSE
IS THIS REPORT MADE BECAUSE OF AN OFFICIAL INSTRUCTION OR STANDARD PROCEDURE: YES / NO | IF YES GIVE NAME & DATE
WHEN
HOW OFTEN IS IT PREPARED | HOW MANY COPIES | HOW MUCH TIME DOES IT TAKE TO PREPARE
HOW IS IT PRODUCED: HAND / TYPEWRITER / OTHER
LIST SOURCES OF DATA USED IN PREPARATION OF REPORT
DISTRIBUTION OF COPIES

	NAME OF PERSON	TITLE OR POSITION	LOCATION
1			
2			
3			
4			
5			
6			
7			
8			

PLEASE LIST ANY OTHER COMMENTS OR RECOMMENDATIONS REGARDING THIS REPORT
SIGNED | TITLE | DATE

Fig. 5. Questionnaire for report originator

of more reports with more figures. One danger is that the accounting department may drift into the habit of issuing more reports than the recipients need or can use effectively. Another danger is that the really significant figures and reports may be overlooked in the sea of data.

The NAA Committee on Research reported in NAA Research Series No. 28 (NAA Bulletin, vol. 36):

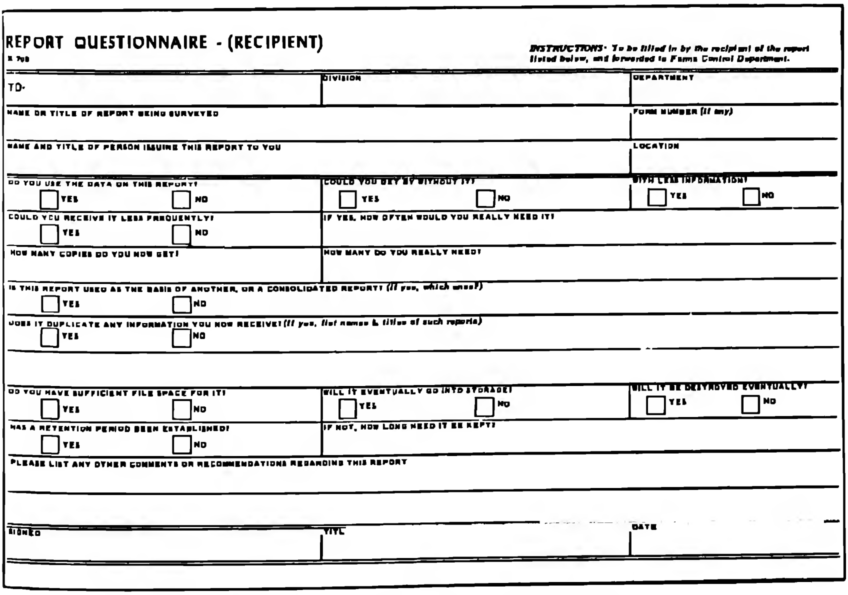
> Many companies review their entire list of accounting reports periodically. At this time, recipients of reports are asked whether or not they still need each report and, if so, how it can be made more useful. A majority of the companies participating in this study make such a review annually, but in some cases it is made at longer intervals or when it seems desirable.

In Figs. 5 and 6 Marien (Controller, vol. 27) shows two survey forms that are helpful in eliminating unnecessary reports and in improving others.

CAUSE ANALYSIS AND COMMENTS. As there is always opportunity for improvement, analyses should be made continually of all important cost items. Heiser (Budgeting—Principles and Practice) lists the basic requirements in **analyzing and reporting performance** in cost incurrence control as:

1. Departmentalization of activity and responsibility.
2. Valid comparisons.
3. Useful reports.

While **standards and budgets,** especially flexible budgets, give a timely and valid measurement of performance, they only provide good clues by helping to localize the area of difficulty and by indicating its quantitative significance in physical units or dollars. Those areas in which the costs are consistently higher or lower than standards or budget must be carefully examined by the cost accountant and appropriate operating personnel to isolate the cause. The



REPORT QUESTIONNAIRE - (RECIPIENT)

INSTRUCTIONS: To be filled in by the recipient of the report listed below, and forwarded to Forms Control Department.

TO:	DIVISION	DEPARTMENT
NAME OR TITLE OF REPORT BEING SURVEYED		FORM NUMBER (if any)
NAME AND TITLE OF PERSON ISSUING THIS REPORT TO YOU		LOCATION
DO YOU USE THE DATA ON THIS REPORT? ☐ YES ☐ NO	COULD YOU GET BY WITHOUT IT? ☐ YES ☐ NO	WITH LESS INFORMATION? ☐ YES ☐ NO
COULD YOU RECEIVE IT LESS FREQUENTLY? ☐ YES ☐ NO	IF YES, HOW OFTEN WOULD YOU REALLY NEED IT?	
HOW MANY COPIES DO YOU NOW GET?	HOW MANY DO YOU REALLY NEED?	
IS THIS REPORT USED AS THE BASIS OF ANOTHER, OR A CONSOLIDATED REPORT? (If yes, which ones?) ☐ YES ☐ NO		
DOES IT DUPLICATE ANY INFORMATION YOU NOW RECEIVE? (If yes, list names & titles of such reports) ☐ YES ☐ NO		
DO YOU HAVE SUFFICIENT FILE SPACE FOR IT? ☐ YES ☐ NO	WILL IT EVENTUALLY GO INTO STORAGE? ☐ YES ☐ NO	WILL IT BE DESTROYED EVENTUALLY? ☐ YES ☐ NO
HAS A RETENTION PERIOD BEEN ESTABLISHED? ☐ YES ☐ NO	IF NOT, HOW LONG NEED IT BE KEPT?	
PLEASE LIST ANY OTHER COMMENTS OR RECOMMENDATIONS REGARDING THIS REPORT		
SIGNED	TITLE	DATE

Fig. 6. Questionnaire for report recipient.

presentation of such analysis with interpretive comments in reports enables all members of management to work more effectively for cost control, both individually and as a team.

Bennett (Standard Costs: How They Serve Modern Management) stresses the critical importance of cause analysis in achieving management's control objectives and says that, "the analysis of cost variances is usually the most important job to be done in operating a standard cost system."

In order to make investigation of causes easier and to minimize the effect of various inefficiencies, Blocker and Weltmer (Cost Accounting) recommend **promptness in reporting and investigating variances:**

> Control of production and costs is a matter of timing; the effectiveness of the control is often in direct proportion to the speed with which a change is recommended after an unsatisfactory operating condition is discovered. Therefore it is important to focus managerial attention on off-standard conditions immediately following each shift, day, or week rather than to accumulate and summarize variances from standard each month. A month, and generally even a week, is too long a period for many off-standard conditions to remain unchecked and uncorrected. . . .

NEED FOR FOLLOW-UP. Cause analysis will frequently reveal some **controllable conditions** which can be adjusted by a particular operating supervisor and other causes which are controllable outside that department, i.e., by other operating or service departments or through management personnel at middle or top management levels. **Spoilage,** which is a constant and important problem for most firms, illustrates the fact that there are few cost elements that are completely and solely the responsibility of one person (see section on Materials).

Since any one cost element may have **multiple causes,** it is necessary that there be follow-up reporting and action. Recognition of this characteristic of many control problems led one firm to the following **method of improving communication** and coordinating action as reported by Webster (NAA Bulletin, vol. 37):

> It was these reports on variances which we did not feel were receiving sufficient attention to make them effective tools. In taking a fresh approach to this problem we first talked with each plant manager and persuaded him [to accept] the help which was his for the asking if he could arrange his schedule to conform with a proposed program. This program asked him to set aside one hour on each of seven consecutive days each month, beginning with the eighth working day, for staff review of the preceding month's results. Since most of our managers are in charge of multi-product and multi-operation plants, to attempt to review the entire plant performance at one time would entail at least a full day's discussion. The schedule of one hour on seven consecutive days avoids the boredom which can result from too long a period of conferring and makes it possible to limit the personnel to be in attendance at individual meetings to those interested in the problem under discussion.

The cost accountant's responsibility involves recording, measuring, interpreting and reporting so that the productive resources of the firm are used effectively. He should strive to devise or suggest means of accomplishing these functions in a more timely fashion, or at less cost, or in a way that will promote necessary corrective action.

EFFECTIVE USE OF REPORTS. Reports inform, people perform. Consequently the human element is critical in the success of any cost control program. The basis for cooperation between the preparers and users of cost control data must be carefully laid and continuously strengthened through better mutual

understanding as it is utilized. Cost control means action. It is the accountant's responsibility to do all he can to improve the means of communication so that action will be taken promptly and on the basis of reasonably accurate information. Nelson (NAA Bulletin, vol. 39) indicates the importance of **cost control team work** and the accountant's function in it as follows:

> Teamwork is the most vital ingredient required for success in controlling costs. The figures in accounting reports should serve the same purpose as the signals called by the quarterback of a football team. They tell the team what's to be done.
>
> Regardless of the system being used to control costs, no success will be achieved in cost control until a thorough explanation of the meaning of these figures has been given to all supervisors. It is a common experience to find these reports in the hands of supervisors who have only the vaguest idea of how to evaluate the information contained in them.
>
> The time spent by the accounting department in educating supervisors as to the meaning of statistics, the conclusions that can be drawn from them with respect to required action, and the areas in which this action can and should be taken, have high potential for securing cooperation in controlling costs and inspiring the vitally necessary teamwork.

A problem that has proved troublesome to many administrators, especially in the early stages of a budgetary or standard cost system, is that the periodic report will show a number of sizeable variances which should be followed up. Because of many demands on his time, the administrator may not have sufficient time to make an effective analysis of all these variances. There is the temptation to make a quick, superficial follow-up on all the substantial variances so that the person responsible for variance analysis can say, if questioned by higher management, that he did investigate the item and that the loss was due to a specified cause. In many cases, however, such hasty analyses may neither uncover nor remedy the real cause of the loss. The unfavorable variances will tend to continue to show up, period after period, and the harassed administrator may find himself running on a treadmill, making the same superficial review of the variances and registering little progress.

An alternative procedure is to choose for each period only a few, perhaps one or two, of the largest variances and to use all the available time to work intensively on these. The likelihood of discovering the real causes of loss and of taking effective action to remove or minimize them will often be much better under this second method.

PERIODIC COST CONTROL REPORTS. Since cost control is a continuous problem involving all types of productive factors and functions of the business, most cost control reports are designed to meet recurring needs for information.

Reports are most helpful to those with operating responsibility when they are issued either daily or weekly (as seems appropriate in the circumstances) and localized as to one or more of the following factors: department, production run, operator, types of materials, machine, and cause.

Summary reports on materials, labor usage, and labor-related costs, and controllable overhead are useful in assisting plant managers, and those in top management concerned with manufacturing operation, in measuring the performance of those responsible to them and in obtaining information which may indicate that higher-level follow-up or improved planning is required.

REPORTS FOR SPECIAL NEEDS. A system including budgets, standards, statistical controls, and the related performance and information reports will

RESEARCH PROJECT APPRAISAL

TITLE: ____________________

BUDGET ITEM OR PROJECT NO. ____________

PROPOSED $ ____________ **PERIOD** ____________

A. RESEARCH ASPECTS: 1. PROBABILITY OF SUCCESS Omitting financial factors, consider only the probability that the research and development phases of the project will produce a useable result (e.g. new process, product, field of application, engineering tool, etc.).	Crowded research field and/or difficult to foresee successful solution of technical problems.	Average prospect for successful technical development in field of moderate competition.	New or open field, successful technical development highly probable.
	Remarks:		
2. ESTIMATED RESEARCH COST Consider total development cost (including laboratory, pilot plant, patent, etc.).	Relatively high total cost. Estimated at $ ________.	Problems of recurrent nature, requires average annual expenditure of approximately $ ________.	Low or moderate total cost. Estimated at $ ________.
	Remarks:		
3. TIME Estimate total years required to complete projected work at proposed rate.	Long range. Three or more years.	Intermediate range. One to three years.	Short range. One year or less.
	Remarks:		
4. OTHER			
B. ECONOMICS: 1. ESTIMATED NET ANNUAL EARNINGS OR SAVINGS (OR OTHER FINANCIAL BENEFITS) Includes all cost factors such as taxes, depreciation allowance, etc.	$50,000 or less. Estimated at $ ________.	$50,000–$500,000. Estimated at $ ________.	Above $500,000. Estimated at $ ________.
	Remarks:		
2. ESTIMATED CAPITAL INVESTMENT	Above $1,000,000. Estimated at $ ________.	$100,000–$1,000,000. Estimated at $ ________.	Under $100,000. Estimated at $ ________.
	Remarks:		
3. ESTIMATED PAYOUT – CAPITAL INVESTMENT Capital Investment (B-2) + Annual Net Earnings (B-1) (Net earnings allow for all tax costs)	More than three years.	One to three years.	Less than one year.
	Remarks:		
4. ESTIMATED PAYOUT – RESEARCH EXPENDITURES Total Research Cost (A-2) + Annual Net Earnings (B-1) (Net earnings allow for all tax costs)	More than three years.	One to three years.	Less than one year.
	Remarks:		
5. ESTIMATED PAYOUT – over-all combination of 3 and 4 above	More than three years.	One to three years.	Less than one year.
	Remarks:		

C. MANUFACTURING ASPECTS 1. EFFECT ON OPERATIONS Consider facilities requirements, availability of raw materials, effect on refinery balance, availability of suitable location, conflicts with other operations, etc.	... problems	... operation	... operation
	Remarks		
2. ALTERNATIVES Consider other possibilities for attaining desired objective.	Result better achieved by other means e.g., consultant, engineering firm, etc.	About equal for CRC development vs. other means.	CRC program best means to desired objective.
	Remarks		
3. OTHER			
D. MARKETING ASPECTS: 1. NEED Extent to which a successful research development is necessary or desirable from a marketing standpoint.	No apparent need.	Desirable to maintain or expand position.	Essential in relation to current or projected markets.
	Remarks'		
2. EFFECT ON OPERATIONS Consider relation to other products, requirements for distribution and marketing facilities, marketing advantages or disadvantages, and special marketing requirements.	Will create conflicts with present operations	No major problems anticipated.	Expected to coordinate readily with current operations.
	Remarks		
3. ALTERNATIVES Other possibilities for desired objective.	Preferable to purchase or license from others.	About equal prospects for CRC program vs. other possible alternatives.	CRC program best means to desired end.
	Remarks		
4. OTHER			
E. PROBABILITY FOR SUCCESSFUL COMMERCIAL DEVELOPMENT: Estimate over-all prospect for success based on combined appraisal of the above major considerations (A, B, C & D).	Low 1 2 3	Intermediate 4 5 6 7	High 8 9 10
	Remarks		

	Not Justified	Marginal	Average	Above Average	Outstanding
F. OVER-ALL APPRAISAL OF PROPOSED PROGRAM: Taking account of the above factors and your estimate of their relative importance, rate this project in relation to others available for inclusion in the current program.	1 2	3 4	5 6	7 8	9 10

Prepared By__________________ Date ______________

Fig 7. Research project appraisal report form.

provide the basic information for most management operating decisions. Foremen and plant managers accustomed to using these modern control techniques read the recurring reports and sometimes select items on which they desire more information. Their questions usually begin with: "Why?"; "What caused this?"; "What is the real cost impact of this?" At this point additional **investigation and summarization of findings** is usually required before final decisions can be made. Such trouble shooting is most important in production management, but the accountant with an interest in, and understanding of, plant operations should bring out of the available **quantitative controls information** which anticipates operating needs and forewarns of impending trouble. Scott (NAA Bulletin, vol. 38) indicates a number of ways in which accountants can promote cost control by being helpful before the fact:

> The accountant should be receptive to designing and furnishing reports which are simple and contain information needed by production management. If an accountant were queried as to what absentee costs add to manufacturing costs for the current month, he would be hard put to give a direct answer. Likewise, if the average accountant were asked what it cost the company to have an unstable labor load and product variation from month to month, he would be hard put for an answer. . . . Other hidden costs are going on every day in every company, and the accountant has responsibility of revealing them, top-side.
>
> Serious endeavors to develop a series of ratio reports showing the degree of effectiveness, by plants, of the scrap control program, the turnover and absentee control program, the quality control cost factor of the product buildup, the actual hourly costs which include downtime, underproductivity, and shop inefficiencies call for creative powers of high order.
>
> Automation is essential to low-cost production. The accountant must help in the determination of formulas which give guidance to determine whether automation projects are sound financially

The most important time to provide adequate information for cost control is before decisions are made to commit men, materials, machines, and facilities to the operating programs of the firm. Special problems arise continuously which are related to purchasing, production, inventory control, changes in distribution methods, labor, research, etc. **Special studies** are necessary to develop the relevant information and to present special reports to management which will enable them to select, or strive for, those programs which will most effectively use the firm's resources.

There can be no established content or form of presentation for special reports. Each is designed specifically for the purpose it is to serve. Since research is a first step toward committing resources for the long run, careful planning, including **study of cost planning**, must be brought to bear on each project by appropriate specialists within the firm. This may prevent certain unwise or unnecessary expenditures or assure the effective utilization of existing or expanded facilities.

In prescribing **cost controls for research**, Gesick (Controller, vol. 24) gives an illustration of a special report (see Fig. 7):

> An illustration which should be self-explanatory of the thought that should go into research planning is the Research Project Appraisal report form of the California Research Corporation. Analysis of this appraisal form will indicate that not only is there an evaluation of a project by the director of research but here we also find information needed from the following other members of the team:
>
> 1. Cost and investment payout from the financial department.
> 2. Manufacturing aspects from the manufacturing department.
> 3. Marketing aspects from the sales department.
> 4. Economic evaluation.

ACKNOWLEDGMENTS

In the preparation of the ACCOUNTANTS' COST HANDBOOK, reference has been made to virtually the entire literature of cost accounting and related areas. With full appreciation for the value and significance of the contributions to the field made by the authors and publishers of all of these works, the editor of the HANDBOOK wishes to give special acknowledgment to the following publications which have been cited or quoted in the ACCOUNTANTS' COST HANDBOOK.

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Machinery and Allied Products Institute (MAPI)
Municipal Finance Officers Association
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